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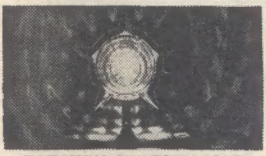

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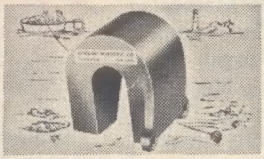

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LAST SPRING, the British Medical Association ruled that dying people who were possible organ donors must not be moved to a hospital where a recipient was waiting. They called the practice "ethically unacceptable." Since then, more voices are rising about the lack of any clear cut ethics or control of scientific excesses. At a recent forum on the subject, Harvey Wheeler, co-author of the book *Fail Safe*, told a disconcerted scientific gathering, ". . . The day when scientists can be left free to do anything they want is finished

THIS MONTH

—or should be." His list of questionable applications of new data included nuclear warfare, environmental pollution, supersonic aircraft and electronic invasions of privacy. His remarks brought a flood of dissent from the floor, but the fact remains that some sort of c o n t r o l over application of the wildly proliferating scientific advances must be maintained if we are to survive as civilized human beings. Some breakthroughs already on the horizon are enough to make anyone's hair curl: brain and behavior control; remaking people by cloning; electronic marvels undreamed of. Anyone who doubts the malevolent potential of the pure knowledge that is piling up, need only read the books beginning to appear on these subjects. Gordon Rattray Taylor's *The Biological Time Bomb* (*Science Digest*, Oct. 1968), was one of the first. Now Albert Rosenfeld, Science Editor of *Life* magazine has written *The Second Genesis: The Coming Control of Life*. The review is on page 91.—*RFD*

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The mysterious secrets of hypnotism turn out to be not so mysterious after all. Too many years of theatrical tricks and misconceptions have clouded what hypnotism really is. Find out on page 7.

Cover photo by Bob Berger

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NEWS IN BRIEF/Bulletins at press time

American flag stands firmly implanted on the moon's surface—symbol of a "giant step."

WHERE DO WE GO FROM HERE IN SPACE? America's moon spectacular eclipsed a lot of other hard news in the world, as well as in space -- including Mariner's close fly-by of Mars. Will more spectaculars in space be coming up? Yes. NASA's timetable calls for the following: Another moon landing in November or December -- this one to sit down on the Ocean of Storms. After that, at least two -- and perhaps as many as eight -- Apollo explorer trips will be launched to a variety of luner locations during 1972 or '73 -- some of them lasting up to three days on the surface while astronauts travel over the terrain on moon buggies (Science Digest, April, 1969). Our first manned earth-orbiting space station is due to launch in 1972 as an astronomical observatory. Meantime, everyone is making wild forecasts. Dr. Thomas Paine, NASA's administrator, calls for rocket plane round trips (economy class) to a comfortable space station by 1984. Cost: "several thousand dollars." Nuclear rocket shuttles, he says, will carry passengers to and from lunar orbiting

UPI Photos

Astronaut Aldrin sets up solar wind device (left). Armstrong (right) takes soil samples.

stations. Earth-moon trips will cost about $10,000. President Nixon believes we'll be exploring a planet with life on it by the year 2,000. Not to be outdone, Vice President Agnew thinks we'll be heading for Mars shortly. Up to press time, the budget-trimmers have been very quiet.

A NUCLEAR-POWERED HEART PACEMAKER, fueled with Plutonium 238, has been regulating the pulse of a dog named Brunhilde at Brookhaven National Laboratory since early June. The unique gadget, if it continues to function as expected, may become a great boon for heart patients. It is designed to produce regular heart beats for at least 10 years without replacement. Current mercury cell pacemakers require replacement every two years. (See page 63.)

TROUBLES PLAGUED LOCH NESS last summer. Great white hope of the monster investigating committee was a little submarine built by an oceanographer, Dan Taylor, of Atlanta,

Georgia. First it developed a leak in the hatch, then a stern plate came loose and it sank at its pier in the loch. With these fixed, the motor burned its brushes. Result: the "monster" will enjoy another year of privacy.

THOR HEYERDAHL'S PAPYRUS REED BOAT TERMINATED its voyage 10 days short of the island of Barbados, after having sailed 2,600 miles of stormy Atlantic from Morroco. Object of the trip was to prove that it would have been possible for ancient Egyptians to cross the sea in primative craft, bringing their culture to Central America. Heyerdahl's vessel, built to the ancient specifications was partially dismasted in 18-foot seas, and Heyerdahl decided to transfer the crew and scientific instruments to a fishing trawler, even though the Ra was still bouyant and drifting westward at 25 miles per day.

VENUS HAS MOUNTAINS AND VALLEYS ranging to a 50,000-foot differential, according to data returned by instrumented capsules parachuted to the surface of that planet by the Russians last Spring. Neither capsule reached the surface, since both were crushed by the massive atmospheric pressure that reaches 140 times the pressure of air on the earth's surface. Presence of mountains on Venus poses an enigma, since the surface temperature, estimated at 1000° F., indicates a molten mass in which a mountainous crust could not be supported.

WALKING CATFISH ASSUME PLAGUE PROPORTIONS in Florida, as the strange creatures spread out across 1,000 square miles, meandering from pond to pond. The fish, similar to the ordinary variety, has the added ability to climb out of the water and wobble across land for considerable distances. Feeding on minnows and bottom life, a few walking catfish can devastate a pond in a short time, then they move on to another. They started as an imported novelty for aquariums and backyard ponds. A few got loose, and proliferated in the friendly Florida climate. Now they're a menace. Some wiggle along on their pectoral fins. Most bigger ones (about a foot long) turn over on the dorsal fin spine, arch the back and flip forward, moving several inches at a time by this maneuver. The fish can remain out of water for periods of more than 24 hours where soil is moist enough to keep their skin wet.

HYPNOSIS: what it can and can't do for you

You don't need any help from mysterious hypnotic forces in order to be strong or withstand great pain. Your own potential is probably a lot greater than you think.

by Richard F. Johnson

"YOUR EYES are becoming heavy," chants the stage hypnotist. "They are closing. You are becoming relaxed . . . more and more relaxed . . . drowsy . . . very drowsy and sleepy. You are going into a deep sleep."

The young man from the audience stares intently at a shining watch fob as the hypnotist swings it back and forth in front of him. More soothing words: ". . . drowsy, sleepy . . . deep sleep." The young man's head droops; his face looks peaceful—he has been "hypnotized."

"Now, when I snap my fingers, your whole body will become as stiff and as rigid as a wooden plank," says the hypnotist. "In fact, your body will become so rigid that you'll be able to suspend yourself between two chairs with only your head and ankles as supports."

The fingers snap, the man goes rigid and sure enough he *can* be suspended between the two chairs. The audience gasps its inevitable gasp—and once again the power of hypnosis is proven. Or is it?

Recently psychologists have been asking an important question: Can amazing feats like the rigid body trick be performed without hypnosis? Intensive research conducted during the past decade shows that the amazing feats attributed to hypnotism

Illustrations Bettman Archive

The old chair trick has been around practically since time immemorial. It looks very difficult and mysterious, but actually nearly anyone can do it with ease for as long as four minutes.

may well be within the capabilities that all of us normally possess but rarely use. Although the hypnotist can lead his subject to perform impressive feats like withstanding severe pain, lifting very heavy weights and becoming a "human-plank" like the young man from the audience, any normal individual who is highly motivated can do the same thing.

Furthermore, it now appears misleading to say that the hypnotist's subjects behave in unusual ways because they are in a "trance." Hypnotic behavior can be more easily explained as due to a change in the subject's attitudes, expectancies and the willingness to cooperate.

This new viewpoint toward hypnosis derives from several hundred investigations that have been published in recent years.

At the Medfield Foundation in Harding, Mass., Dr. Theodore X. Barber has shown that four out of every five individuals are normally able to stay suspended between two chairs when they are simply asked to make their bodies rigid. Similarly, research conducted by John K. Collins at the University of Sydney in Australia has demonstrated that the average man or woman can remain suspended for up to four minutes. Absolutely no attempt was made to hypnotize these people. They were genuinely surprised at their own abilities, stating, for example, "I didn't

know it could be so simple," and, "I don't believe it; let me do it again."

Dr. Martin T. Orne, formerly at Harvard and now at the University of Pennsylvania, has challenged the notion that hypnotism can produce a dramatic increase in strength. Nine men were exposed to a hypnotic induction procedure, given suggestions that they would not feel any fatigue, and then asked to hold a heavy weight at arm's length for as long as possible. Later, the same men were told, under normal conditions, that they were not performing better than women and that they would receive as much as $1.60 if they held the weight for a longer period of time. The men showed much greater strength and endurance, not under the hypnotic condition, but under the awake, motivated condition.

At times, hypnotists command their subjects to become completely deaf. A pistol is then fired. Later, when asked if they heard anything unusual, some subjects reply, "No." Does this mean that the hypnotist actually succeeded in making the person deaf?

Scientists have worked out objective tests for determining whether or not a person can hear. On numerous occasions it has been shown that the hypnotic subject, who insists that he cannot hear, fails to perform on these tests as would a deaf person. In other words, the "hypnotic deaf" subject really can hear. It's as if he were trying his best to block out sounds, but does not succeed in doing so. At times, the fact that the subject can hear may be surprisingly obvious. After suggesting to the subject that he is totally deaf, the hypnotist may quickly ask, "Can you hear me?" Some subjects reply, "No, I can't," blatantly admitting that they can hear.

Some stage hypnotists also stick pins into their subjects, while the subjects apparently remain calm and unconcerned. Has the hypnotist actually succeeded in making them insensitive to pain?

A recent experiment at the Medfield Foundation showed that pain can be reduced by suggestions regardless of whether or not a hypnotic procedure is used. The subjects were young student nurses. Pain was produced by the force of a heavy weight bearing down on a small area of one finger. The student nurses were distracted while they were being exposed to the painful stimulus by having them listen to, and try to remember, the details of an interesting story. The story, which was played on a tape recorder, concerned a now famous actor who was a thief at the age of ten, had three illegitimate children by age 15 and had various other interesting experiences prior to his movie career. When the subjects were distracted in this way, they reported little pain regardless of whether or not an attempt had been made to hypnotize them. When the distracting story was not played on the tape recorder, they reported pain even though some of them had been exposed to a hypnotic induction procedure. Dr. Barber concluded that, "distraction tended to be more effective than the hypnotic procedure in reducing pain."

Other experiments carried out at Medfield have demonstrated that many people are highly responsive to suggestions even when no attempt is made to hypnotize them. College students, who thought they were being tested for imaginative ability, were

told to imagine that their hands were locked together like two pieces of welded steel and that the harder they tried to take them apart, the more strongly they would become locked together. Half the subjects who had *not* been exposed to any hypnotic induction procedure were unable to take their hands apart when challenged to do so. In addition, they reported that their hands "really felt stuck together."

Each subject was also told that he was unable to rise from his chair, could not speak his own name and would forget specific things that occurred. With no attempt to hypnotize these subjects, at least 20 percent passed *all* the suggestibility tests and stated that they actually felt the things that were suggested.

Degree of suggestibility

Prior to the recent upsurge of research in this area, most writers assumed that hypnotic induction procedures raised suggestibility far above the normal level. However, experiments conducted during the past decade have demonstrated that subjects generally show a small increase in suggestibility after they have been exposed to hypnotic procedures.

In fact, Dr. Ernest R. Hilgard of Stanford University noted in the recent book, *Hypnotic Susceptibility*, that scientists can easily miss the small differences in suggestibility that distinguishes hypnotic from non-hypnotic control subjects, simply because the difference is so small.

Experiments have shown that there are at least two inconspicuous aspects of the hypnotic induction procedure which make people more suggestible than they are normally.

First, the hypnotist defines the situation to the subject as hypnosis. Let us suppose that you are told by a scientific experimenter that he is going to make an attempt to hypnotize you. Simply because you are now in a situation that has been defined as "hypnosis," you believe that you are about to have interesting experiences and will be able to do things that you have never done before. Research at Medfield has demonstrated that simply telling a person he is in a hypnosis experiment, rather than in some other kind of experiment, is sufficient by itself to raise the subject's normal level of suggestibility.

Secondly, the hypnotist usually makes doubly-sure that his subjects are motivated to do their best. He typically states:

"I want you to cooperate fully and really try to experience the things I am about to suggest. Pay close attention to what I tell you, and think of the things I tell you to think about. Most people find this a very interesting experience. If you really try, you'll be able to experience the many things I will tell you to experience."

Motivational instructions such as these, *when given alone*, are also sufficient to raise suggestibility above the normal level. In fact, a high level of suggestibility can be produced by two methods: *either* by simply motivating the subjects to cooperate, *or* by repeatedly suggesting to them that they are becoming relaxed, drowsy, sleepy and are entering a hypnotic state. Why do both of these methods raise suggestibility? It may be that both methods are effective because they motivate the subjects. Dr. Barber explains:

"Telling people that they are be-

Hypnosis might better be called "motivation," because scientists believe they achieve the same things.

coming more and more relaxed, drowsy, sleepy and are entering a hypnotic state implies to most present-day subjects that (a) they are in an interesting and unusual situation, (b) they should cooperate and try to follow instructions, (c) if they cooperate, they will be able to do things they had not done before, and (d) if they resist, they will ruin the experiment and disappoint the experimenter."

If Dr. Barber is correct, it would follow that when a hypnotist "hypnotizes" someone, he is at least in part motivating that person to do something he has never done before. Much research tends to support this conclusion. The motivated subject can withstand just as much pain as the hypnotic subject, can remain suspended between two chairs for the same length of time, can manifest as much, if not more, strength and endurance and so on. It seems that the main obstacle to performing a "hypnotic" feat, such as the human-plank, is a simple lack of confidence. Each subject must see that the task is safe, and that it can be done well if it is only tried. Since the task only appears difficult, confidence is the key to its performance.

Motivational methods are used by all of us almost every day, even though we would not think of calling them hypnosis. For example, coaxing a child to make his first dive into a swimming pool by telling him that he can do it and to really try, is not thought of as hypnosis. Yet, it seems that this is primarily what the hypnotist does: he tries to change the person's motivations, expectancies and attitudes toward a task.

Not too many years ago it was assumed that the hypnotist gets his subjects to perform in unusual ways because he has placed them in a "hypnotic trance." However, recent research suggests that we might be able to explain the unusual performances without referring to a trance state. Investigators, such as Dr. Theodore R. Sarbin of the University of California at Berkeley, and Dr. Barber, have pointed out that the term "trance" has been used in an ambiguous fashion. For instance, a person is said to be in a hypnotic trance when he is highly responsive to the hypnotist's suggestions. The basic underlying problem arises when we ask, "Why is the person so responsive to suggestions?" Until recently, the answer would have been:

"Because he is in a hypnotic trance."

"But how do you know that he is in a hypnotic trance?"

"Because he is highly responsive to suggestions."

And so on, endlessly. The usage is circular and leads nowhere. Since the notion of a hypnotic trance is supposed to explain the high level of suggestibility, it is meaningless to turn around and say that a person is in a hypnotic trance because he is highly suggestible.

Even though the notion of a hypnotic trance is not necessary to explain this type of behavior, don't some subjects enter a trance after they have been exposed to a hypnotic induction procedure? Some in-

vestigators see this as a possibility. However, difficulties arise when one tries to define the hypnotic trance state in a manner which lends itself to scientific investigation. Someone might be judged to be in a trance because his eyes are closed, he is slouched over in his chair and he seems to be passive and very relaxed. Indeed, hypnotic trance was once thought to be a state between sleep and wakefulness. However, people who are highly responsive to the hypnotist's suggestions do not necessarily look passive and relaxed, as if they are in a trance. In fact, if the hypnotist tells the subject to open his eyes and look alert, he will immediately take on a wakeful appearance and continue to perform the acts that the hypnotist suggests.

No physiological changes

At Stanford University, Dr. Hilgard has noted that some subjects state that they were in a trance or were hypnotized because they felt different. However, subjects' statements are always too varied to permit us to say that there are distinct feelings unique to all hypnotic subjects. In a review of pertinent research, Dr. Hilgard pointed out that, "Even among subjects who responded well, only some two-thirds felt confident that they could tell when they were in a hypnotic state."

It should also be emphasized that many researchers have tried to find an objective, physiological index of hypnosis, such as a change in brain waves, pulse, respiration or electrical conductance of the skin. However, to date, no one has been able to demonstrate that any physiological measure changes consistently as a result of hypnotic procedures. In fact, present-day physiological techniques are unable to distinguish the hypnotic subject from the subject who is normally awake.

The major effect of recent research has been a shattering of many assumptions about hypnosis that were at one time taken for granted.

Some earlier investigators assumed that clever hypnotists can induce some of their subjects to commit dangerous, immoral or criminal acts. Although there are many anecdotal reports bearing on this question, there are very few documented cases. In one documented report, a young housewife insisted that she had been seduced by a strange man who later compelled her, via hypnosis, to become a prostitute, steal money from her husband and attempt suicide. According to a documented case from Denmark, a Mr. H. insisted that a hypnotist had made him commit bank robbery and double-murder. However, in each case, the person committing the criminal act was mentally unstable. For instance, Mr. H. heard voices from a "guardian spirit" and had a "grandiose plan to unify Scandinavia and create a Utopian society." Also, the person accused of doing the hypnotizing was not known to be a hypnotist and denied that he had ever hypnotized anyone. Aside from this, there were many other factors which could have led to the criminal acts. For instance, the young housewife had been involved sexually with the accused hypnotist, and needed money in order to escape her problems. Mr. H. had previously shared a prison cell with the person who allegedly hypnotized him, and their close friendship had the character of latent ho-

It may be a long time before laymen give up the old tales about the mysterious powers of hypnosis.

mosexuality. Not only that, but after the so-called hypnotist was tried and convicted, Mr. H. changed his story to say that he had never been hypnotized by anyone.

In Dr. Orne's laboratory, hypnotic subjects and non-hypnotic control subjects were commanded to throw acid at a person's face and pick up a venomous snake. Almost all of the subjects complied with these commands. However, in reality, it was perfectly safe to respond to these commands, since there was an invisible glass shield which stopped the acid from reaching the person's face and stopped the hand from touching the snake. Later, during an interview, all subjects stated that they thought it was perfectly safe to comply "because they were participating in research conducted by competent, responsible scientists," and they could not believe that scientists would allow anyone to be hurt in their experiments.

Another popular assumption is that hypnotic procedures can increase the effectiveness of psychotherapy. Although this assumption has not been shown to be false, it has also not been shown to be true. Psychotherapy is a very complex relationship between two individuals. Many things enter into psychotherapy, a hypnotic procedure being only one possible means of improving memories, images and free associations. Authorities in the area of psychotherapy agree that it is very hard to pin down what hypnotic procedures actually do and whether they are really the cause of any apparent improvement. Since there are so many different facets to any one psychotherapeutic relationship, it is difficult to disentangle the effects of a hypnotic procedure from the many other complex events that are occurring at the same time. In addition, there has been no controlled evaluation of hypnotherapy as compared with any other type of therapy.

Even though scientific evidence continues to mount showing us that hypnosis is better conceived as a change in attitudes, expectancy and the willingness to respond, it may be a long time before this view filters down to the public and is finally absorbed. We may expect many years to pass before laymen give up the false notion that the hypnotist places his subject in a *trance* and that the *entranced* person is compelled to do whatever the hypnotist commands.

Within the scientific world, the main effect of this recent research has been a new interpretation of hypnosis. Hypnotism is now viewed as neither special nor mysterious. Man does not need the help of mythical forces in order to display unusual abilities such as great strength or high resistance to pain. His potential is simply much greater than he has allowed himself to believe. ■

For further reading

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The hairy people

hypertrichosis portrayed in art

Chances of your child being born with long hair all over his body are one in a billion, but this freak, genetically caused affliction immortalized a 16th century family whose portraits were even painted at royal courts.

by James G. Ravin and Gerald P. Hodge

FEW THINGS could be as shocking to a mother as seeing her child begin to grow long hair all over his body. Fortunately hypertrichosis occurs rarely (the incidence is estimated at one per billion persons). When this has occurred, public reaction to the affected individuals has varied greatly. Hypertrichotic persons have been treated as atavistic half-animals, as carnival exhibits and as treasured addenda to royal courts. Physicians have also been keenly interested in such individuals; there are case studies dating from at least the 16th century. The Latin designation, *hypertrichosis universalis congenita,* has been given to the long growth of body hair.

At birth the hypertrichosis is usually limited to the ears, but during early childhood it becomes generalized. The hair is four to ten inches long, silky and varying in color from silvery gray to pale yellow. It is found on all parts of the skin except the palms, soles, lips, glans penis and the tips of fingers and toes. Probably the most similar kinds of hair from the animal kingdom are found on Angora cats and Skye terrier dogs. Hypertrichosis is transmitted as a dominant trait, but there have been too few cases reported to define the genetic process adequately. The absence of deciduous and permanent teeth in the cuspid, bicuspid and molar areas is a usual accompanying factor. Because of the coexistence of abnormalities of the teeth and hair, the anomaly is classified as a congenital ectodermal defect.

The case of an African girl born in 1964 is the most recent to be reported. When she was first seen at 48 hours after birth, fine light gray hair up to 1½ inches long was noted over the body, limbs and face. Long tufts of hair projected from the ears and nostrils. At six months of age the body hair decreased to a fine down, but the hair in the nostrils and ears remained thick. There was no new hair growth at one year of age and no teeth. No further information is available.

The first well-recorded example is

Hairy body, depicted even in early 1500s, as "The Savage State," by Jean Bourdichon.

Reprinted by permission of JAMA, ©1969 The American Medical Association.

Painting of Peter Gonzales' daughter shows she inherited her father's hypertrichosis. Information from records of physicians who examined the Gonzales family indicate that two other children were hairy, and at least one child passed the trait to the next generation.

that of Peter Gonzales, who was born in the Canary Islands in 1556. Soon after birth, long dark hair began to grow all over his body. His facial hair had to be curled so that he could see. Because of this unique affliction, Gonzales was sent as a child to the court of King Henry II at Valois, France, to entertain the nobility. European courts of the 16th century often had an entourage of jesters, dwarfs, giants and congenitally deformed individuals who were valued by the aristocrats as entertainers and personal friends. Gonzales, referred to as a "wonderman," was intelligent and the French king liked him. The king had Gonzales given instruction in Latin and courtly manners and permitted him to marry a pretty girl. According to legend, the family was given a cave to live in several years later. The cave was supposedly a replica of those found in the Canary Islands so that Gonzales would not be homesick. During Gonzales' lifetime, savage persons were considered to have the hair of an animal. The degree to which a person was savage i.e., a person's affinity to nonhuman primates) was felt to be directly related to the amount of body hair he had. The reason for the great awe which 16th century Europeans felt toward Gonzales was that he was a savage who had been cultured and refined to the level of any courtly aristocrat.

Often persons with anomalies, such as Gonzales, would be sent to other European courts, perhaps as gifts. Gonzales, with his wife and children, was sent on a grand tour of Europe. Then they went to the Flemish court of Duchess Margaretha and later to the court at Parma, Italy. The trip from Flanders to Parma in 1582 was routed through Munich where their portraits were painted. (In the 19th century, Kaiser Franz Joseph ordered copies of these portraits made to be hung in the famous Allgemeinen Krankenhause in Vienna.)

In 1583 the chief physician of Basel, Switzerland, examined Gonzales and two of his children. Count Ulysses Aldrovandus, another physician, examined the family in 1596. From these sources it is known that at least three of Gonzales' children were hairy, and that at least one child passed the trait to the following generation.

Peter Gonzales, in portrait painted by unknown artist about 1585, was sent as a child to the court of the King of France because of his strange hairy appearance. As an adult he was sent on a grand tour of Europe, during which portraits of his family were painted.

A child by the name of Horatio Gonzales is portrayed in a 17th century etching by Stefano della Bella. Extant records do not reveal the relationship of Peter and Horatio Gonzales, but it is likely that they were father and son. The inscription on the etching indicates that it was a memento created after the death of its subject:

> Portrait of Horatio Gonzales for Mercurio Ferrari. Here you see Gonzales, famous in the court of Rome, On whose human face stood the hair of an animal;
> He lived for you, Ferrari, joined to you in love, And here he lives, breathing in death.

The royal interest in the Gonzales family illustrates the way in which a superficial characteristic can seem unappealing to some people and curiously desirable to others. Truly, the importance of hypertrichosis universalis congenita transcends its apparent obscurity; it is more than just a rare problem in dermatology and genetics. ■

For further reading

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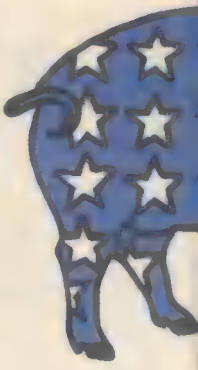
PIGS

those true-blue Americans



by Richard C. Davids

NOBODY SEEMS to love the pig. For years he's been smeared, libeled, excoriated. Oh, we've been told he's the smartest animal in the barnyard. But who has pointed out that he's also the cleanest and the most courageous? And the most generous to man: he stores a third of what he eats (against a stingy eighth for cattle and sheep!) in savory chops and hams and sides—a walking pantry.

The tragedy is—quoting an old proverb—that pigs, like poets, are never appreciated until dead. So let this be a paean in praise of the pig—patriot, benefactor, true-blue American.

Pigs didn't come over on the *Mayflower*. They were already here. They crossed the Atlantic with Columbus—Queen Isabella had insisted on it—and again with De Soto and Cortez. Multiplying shamelessly, they provisioned the coastal woods and islands with pork and ham on the hoof, and rescued an occasional boatload of shipwrecked colonists. Pigs helped keep a starving Jamestown alive.

As missionary, trapper and settler moved westward, the pig journeyed alongside. Rangy and lean like the pioneers themselves, the pig could live off the land, run like a racehorse, leap a 4-foot barricade, fight off a wolf, survive cold and blizzards that killed off cattle and sheep—yet he never forgot to swell the clan by 6, 8 or 10 every spring. His offspring—whether salted, pickled or smoked—carried on where the pig couldn't travel. Salt pork was in every explorer's pack; it would outkeep beef by months. Salt pork from South Jersey, boated by night past the British sentries in Philadelphia, helped feed that half-starved army at Valley Forge.

As the nation grew, the tribe of *Sus scrofa domesticus* grew even faster. The three pigs at Jamestown multiplied into about 600 in two years. Motherhood to a pig takes just 3 months, 3 weeks and 3 days. No other barnyard animal multiplies as fast. And nowhere on earth did pigs find such perfect conditions as in

The unsung "hero" of early American history turns out to be clean, smart, courageous and a walking pantry.

America, with its vast, corn-rich soil. Soon pigs began returning from the frontier by barge to feed the seaboard cities. Thousands of other hogs were driven east in large droves along roads later followed by the early railroads.

Before long, pigs were everywhere in America, even in cities. As late as the 1800s, pigs roamed New York City streets as scavengers, and at roundup time there were l i v e l y chases down Broadway, then the social center of town.

Until a few years ago, most farms had a few "mortgage lifter" pigs that fattened on waste corn and therefore cost nothing, but brought in quick money. But no longer. Meat packers demand uniform, fast-grown, d i s e a s e-free hogs in sizable shipments, which only big growers can produce. The slop-fed farm pig is gone. And what a pity—for today's kids may never learn to know the complex personality and charm of his serene majesty.

A pig is truly free from digestive prejudices. Trash or truffle, he'll take both with gusto. In fact, he likes all the foods that humans do, not to mention others. Pigs are gregarious and fun-loving, too, as every farm child knows who has watched them play tag that is astonishingly like the human game. They like to swim, and when ponds get low, I've seem them go "m a n-w i l d" with excitement catching fish.

A British pig, the constant companion of a bulldog, would leap into ■ lake to retrieve a stick, often before the panting dog could get to it. Educated pigs used to tour Europe, trained to ring bells and count. All that saved Louis XI of France from despondency was the sight of dancing pigs, decked out in pants and ribbons.

There is little doubt about the pig's IQ. I once watched an old sow ponder a dilemma. Penned in by a s i n g l e electrified wire, she had learned that she could squeeze under it, suffering a shock but gaining access to a wickedly juicy cornfield.

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She fidgeted for a time, weighing pain against reward. Suddenly she backed up to a far corner of her pen and then, squealing in anticipation of the jolt, raced ahead and under the wire.

If intelligence is equated with ease of adapting to situations, then the pig is a genius. He prefers clean water, but gladly settles for a mud hole. Yet he's no sucker. You can't fool him with an empty pail as you can a horse. "A pig," said Abraham Lincoln admiringly, "won't believe anything he can't see."

Gossipy sows

You should hear the way those old sows gossip, says a friend, Charley Mills of Delaware. Not even the dog has the conversational ability of a pig. A sharp "woof" means danger in any breed. A squeal, depending on pitch and volume, is instantly understood as hunger, fear, pain or sex drive.

For sheer warmth of note and cadence, few songs can beat the lullaby of contentment that a nursing sow grunts to her young ones, and there is comedy in the sweet talk that day-old pigs pour into their mother's ear.

For courage, no mother surpasses the pig. My neighbor in Minnesota could hardly believe what he saw one moonlit night when he was jolted awake by a battle below his window. The roar never let up while he hustled downstairs, searched the closet for gun and shells, and stumbled barefoot through the grass to the pigpen. There inside the pen was a full-grown bear howling with frustration, slashing at a mother sow who was barring the doorway of a shed that held her young. Armed with little but raging courage, her jowls ripped and bleeding, she fought off an animal three times her size.

Pigs have a way of winning the human heart, as farm children know to their sorrow. Louis Bromfield said, "Look at pigs over a fence but never bring one into your life, for when you put an end to his existence, you'll forever after suffer from memories as cannibal and murderer."

On America's farms, pigs—a $4 billion industry—continue to grow up outdoors, but some U.S. growers now keep them in "total confinement," one of agriculture's startling changes. Paul Smart's farm in Lawrence, Kansas, is an example of the efficiency of this method. Through his "pork factory," a four-building complex, go 5,000 pigs a year without spending a day outdoors.

They thrive in a temperature- and humidity-controlled environment with automatic feeding systems supervised by two men. Waste drops through the slatted floors into a covered irrigation ditch filled with circulating water where micro-organisms break the waste down into odorless fertilizers. "People just don't believe we have a hoghouse that doesn't smell," Smart says. There is a marked drop in disease under total confinement, as well as a reduction in man-hours of daily supervision.

As a result of improved strains, better feeding and disease control, the pig's efficiency has vastly improved. Recently he needed about 4 pounds of feed to grow a pound of pork. Today he needs about 3 pounds, and it is possible to have individual pigs under special care make a pound of pork for about 2½ pounds of feed—a ratio that approaches the

Except for apes and other primates, pigs are more like people than any other animal.

phenomenal efficiency of chicken broilers.

Equally impressive is the way the pig has obligingly lost his fat. For years, farmers wouldn't believe that Americans wanted leaner meat. After all, mankind's greatest hunger since the beginning of time was for fat, whether raw as the Eskimos ate it, or subtly folded into cakes, pies and cookies. Farmers kept growing roly-poly, over-fed creatures that won prizes at fairs even though housewives kept boycotting fat meats. Only when detergents began replacing soap, and lard prices tumbled, did the breeders start to modernize the congenial pig.

Once again, his adaptability has been amazing. In 15 years he lost at least 15 percent of his fat, added the equivalent of an extra ham in red meat. Some champion hogs have been known to produce loin chops with an "eye" of red meat almost as big as that of beef!

In a dozen years, pork increased in protein by one-fifth, dropped more than one-third its calories. Many cuts are as low in fat as beef or lamb, and Philip L. White, nutritionist of the American Medical Association, says, "Lean, carefully trimmed pork is useful in therapeutic low fat diets." Of all meats, pork is richest in thiamin and iron.

After feeding nearly five centuries of Americans, the pig has just embarked on a brand-new career—as a laboratory animal. He is as relaxed in the lab as in his favorite mudhole. Except for apes and other primates, the pig comes nearer to the human in anatomy than just about any other animal. Heart, circulatory system, digestive tract, even teeth—all bear striking similarities.

He is also beset with the same ills. He suffers from undulant fever, tuberculosis and flu. Many develop cardiovascular disease. A high percentage—41 percent in some strains—have ulcers. The skin of the white pig, almost naked of body hair, gives easy readings on allergic reactions.

Until the last year or two, however, the laboratory pig has required too much feed and space, too big a dose of expensive experimental drugs—not to mention the squad of strongmen needed to subdue him. Scientists at the University of Minnesota tried to remedy the situation by cross-breeding. The pigs gradually became smaller and smaller—until last year the scientists produced a breed that weighs about 40 pounds at five months and matures at 180 pounds, the weight of an average man. The scientific world is using these "mini-pigs" to test mechanical hearts, effects of radiation, the aging process as well as the onset of arteriosclerosis.

Unawed by the furor, our 18-karat American goes about minding his own humble business without airs. He still eats, drinks and breathes within inches of the ground.

America ought to honor the pig. Why not make him our national mascot, symbol of our democratic spirit, our willingness to serve the world? America would surely be a lonelier, bleaker, hungrier land without him. ■

Are you polluting your own home?

You may be your own worst enemy where pollution is concerned. Your home is a mini-metropolis with its gas fumes, hair sprays, bug exterminators, disinfectants.

by Ruth Winter

AN ELDERLY BOOKKEEPER went to sleep in her New Jersey apartment one evening and was found near death the next morning. A car left in the basement garage with the motor running the previous evening caused carbon monoxide fumes to fill her bedroom above.

A 36-year-old Boston housewife cleaned her kitchen floor one evening just before dinner. She used a mixture of household cleansers, commercial bleach and vinegar. Shortly after her family finished their meal in the kitchen, they became nauseated, headachey and dizzy. They all coughed. In mixing the bleaches and vinegar, the overzealous housewife inadvertently gassed her family with potentially deadly chlorine gas. Fortunately, they all recovered.

These are dramatic cases that

made the newspapers, but actually, all our homes are "polluted" by gases and poisons to some degree.

"Look at the exhaust fan in your kitchen—the caked grease and dirt you see there shows you what you are breathing in," says Dr. Igho Kornbleuh, chairman of the department of physical medicine and rehabilitation at the University of Pennsylvania.

Dr. Kornbleuh, who is also executive vice-president of the American Institute of Medical Climatology, maintains "the government and everyone else pay attention to pollution of the outdoors but not to pollution inside homes and other buildings."

D. M. Vincent Manson, acting chairman of the department of mineralology at the American Museum of Natural History, points out: "The home is the microsized example of the outside environment. Problems which exist in modern cities exist on a smaller scale in the home."

Dr. Kornbleuh and Manson agree, as do many other scientists, that polluted air does not stop at the doors of a building. In summer, when the windows are open, the outside air can circulate freely within. Even in winter, windows and doors are no real barriers to the outside air because no house is hermetically sealed.

Dr. Kornbleuh says, "The internal climate of most homes and offices in the United States is drier than a desert. Many cases of migraine and other types of headaches, rashes, premature skin aging, allergies, respiratory disturbances and irritability are the consequences of exposure to the arid, polluted air within the home."

Deaths from youngsters deliberately inhaling aerosol sprays for "kicks" have been well publicized, but what happens to all of us when we inhale minute amounts of deodorants, disinfectants, cleansers and the other liquids and aerosols we spray around the house?

"No one knows what effect aerosols have when they are mixed together or even sprayed individually," Dr. Kornbleuh says. "The average kitchen today resembles a laboratory more than the old-fashioned place for preparation of family food."

The University of Pennsylvania professor says kitchen gas appliances consume large amounts of oxygen and produce smoke charged with potentially harmful matter. Chlorine from water escapes in steam along with fats and oils used in cooking.

The Home Ventilating Institute maintains that as much as 200 pounds of grease-laden moisture is given off every year in the average kitchen.

"These substances mixed with emanations from gas stoves are only slightly irritating," Dr. Kornbleuh says, but he questions the long-term effect of such irritation.

There are approximately 300,000 toxic or potentially toxic trade name products in the consumer market. Many of these are common household items found under the kitchen sink or on a closet shelf.

Dr. Alan K. Done, professor of pediatrics at the University of Utah Medical Center, has done much to make physicians aware of the many common household products—ranging from dishwasher detergents to garbage can deodorants—which are extremely poisonous.

He says cosmetics are frequently ingested by children, but the effect

is not as deadly as that from common household products. Among those which have caused a very high hospitalization rate, he points out, are lye and corrosives, petroleum products and polishes and waxes (mainly furniture polish). Intermediate in terms of severity of poisoning are pesticides, soaps and cleansers, bleaches and disinfectants and deodorizers.

In total, Dr. Done says, these classes of agents account for 30 percent of the accidental ingestions by children under the age of five in the United States.

Such products may be lethal to adults but in a different way, as the case histories at the beginning of the article demonstrate. A number of deaths have been reported due to people mixing cleaning preparations together. When chlorine bleaches are mixed with strong acids such as those in some toilet bowl cleansers or strong ammonia solutions, chlorine gas is released. Ammonia combines with hypochloride and produces chloramine. Both chlorine gas and chloramine are intensely irritating to the eyes and respiratory tract and may result in death.

Another poison gas, carbon monoxide, kills or adversely affects 7,000 Americans a year right in their own homes.

"With the increase of air conditioning, carbon monoxide has been found in autos, homes, motel rooms and other places when the air intake vent is located near a source producing carbon monoxide," reports the National Center for Urban and Industrial Research.

In addition to acute carbon monoxide poisoning resulting in death, considerable danger lies in daily exposure to low concentration of the gas in the home environment, the government agency says. A person so exposed for prolonged periods may experience headaches, dizzy spells, anemia, weakness, mental depression, nervousness, irritability and circulatory impairment.

The reported number of deaths and injuries from carbon monoxide are believed to be only the "tip of the iceberg" according to public health authorities. They maintain that fatal or near fatal asphyxiations from this cause have received preliminary diagnoses of acute alcoholism, cardiac failure, botulism and viral infection among others. Variations in susceptibility and exposure of members of the same household often result in differing symptoms and various degrees of illness, which further complicates its recognition and correct diagnosis.

Appliances at fault

A recent study by the Memphis and Shelby County Health Department, Memphis, Tenn., found 40 percent of the homes and establishments investigated had one or more appliances that were emitting unduly high levels of carbon monoxide. Gas range ovens, gas floor furnaces and gas space heaters were most often the faulty appliances.

But gas appliances are not the only potential home polluters. There is an ever increasing number of electronic marvels in our homes and as yet, no one is quite sure how much radiation we are receiving from such devices.

Betty Furness, special assistant to President Johnson for Consumer Affairs, when she testified before a

What are the dangers of radiation from color TVs and new, fast-cooking microwave ovens?

senate hearing on radiation control, said: "Such innocent and useful things as exit signs on airplanes, luminescent keylocks, elevator alarm buttons, telephone dials, fuse box markers using radium—all can be potential hazards if they are constructed in such a manner that they give off radiation in excess of the limits set by the Atomic Energy Commission."

The danger of X-radiation from color TV sets has been headline material for months (see "Can your color TV stand a radiation count?," April 1969), but a newer, less publicized radiation problem within the home concerns microwave ovens—new kitchen gadgets that cook food fast (a three-pound chicken can be cooked in just four minutes). Surveys of microwave ovens now in use have been disquieting. A Pennsylvania State Department of Health survey found 71 percent of the microwave ovens in food vending establishments gave off radiation in excess of the set safety standard. A public health survey of microwave ovens in three Western states found 25 percent released radiation ten times or more above the safety level and at Walter Reed Army Hospital, 24 out of 30 microwave ovens leaked potentially hazardous radiation.

"Strangely enough, low frequency microwaves are potentially more dangerous than those of higher frequency," says Dr. Herman P. Schwan, chairman of the biomedical engineering department at the University of Pennsylvania. "At very high frequencies, all the radiant energy is absorbed by the skin, in a similar fashion as sunlight. Since the skin is well-equipped with heat sensors, we are able to recognize undue heating. But at lower frequencies, the radiant energy penetrates the body tissues unequipped to dissipate heat, and the internal temperature elevations, if strong enough, cause tissue damage."

He says there is also a possibility of genetic damage from excess exposure to microwaves.

Another pollutant in the home is asbestos, a fiber so resistant to everything including fire, that once inhaled, it remains in the lungs.

Since the early 1920s, it has been known that asbestos exposure can lead to cancer. In Penage, South Africa, it was found that asbestos miners were contracting lung cancer at a rate of 200 percent above the average population due to asbestos in the air. Asbestos particles in the air of every modern city are now approaching the level of Penage.

Recent studies in New York and Miami have shown that up to one half of all the housewives, blue collar workers and white collar workers in urban areas have unsuspected asbestos fibers in their lungs at autopsy.

Asbestos is used in brake linings, tiles for the kitchen, shingles for the roof, a variety of insulating material, soundproofing material, plastic floor coverings, ironing board covers, pot holders and heating and air conditioning ducts. One kindergarten even allows its pupils to mix asbestos and water to make a cheap

form of playdough. Many children's cosmetics kits and certain powder-water-mix jewelry kits contain it.

Added to air, water and noise pollution may be another—light pollution. Dr. Richard J. Wurtman, associate professor of endocrinology and metabolism at Massachusetts Institute of Technology, says that excess exposure to artificial light may be harmful.

In an article in *Hospital Practice*, a publication for physicians, he says present research indicates that the natural daylight-night cycle influences a number of the body's biologic rhythms, particularly those that depend on certain hormones.

But probably the most common and easily recognized pollutant is dust. There are estimated to be more than 400 million unseen dirt particles floating in one cubic foot of city air.

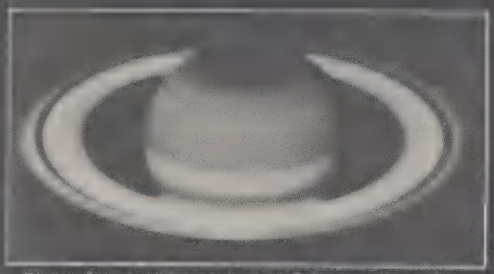
Electronic cleaners can remove up to 95 percent of the dust within a household. But for those who cannot afford electronic equipment, here are ways to minimize dust pollution within the home as recommended by researchers at National Jewish Hospital, Denver:

- Humidity should be between 50 and 75.
- Whenever possible, choose plastics over woolens.
- Use laminated plastics instead of tiles.
- Keep doors to closets closed.
- If a heating choice is possible, choose electric or hot water heat rather than forced air.
- Because the clothes dryer is another source of dust, it should, if feasible, be vented to the outdoors.
- If you must use rugs, they should be low-pile or washable. ■

For further reading

POISONS IN YOUR FOOD. *Ruth Winter. Crown Publishers. 1969.*

science digest



Planet Saturn photographed at Palomar Observatory

Head of a fruit fly magnified 180 times

Macrocosm to microcosm—outer space to the world of the tiny fruit fly—Science Digest explores the excitement of scientific discovery. This pocket-size magazine is crammed with news of fascinating expeditions and research, reviews of reports in science journals and books. Best of all, it is written in non-academic language and provides a cross-fertilization of ideas in business, in the lab, in the school. Start your subscription with coupon below.

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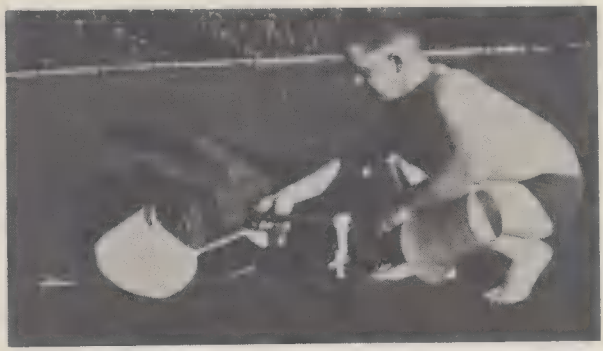
WSD911

NEW FOR PEOPLE

UPI

SPACEGOGGLES are the latest thing in sunglasses from Amsterdam, Holland. Developed by Polaroid, the glasses are designed to enable the wearer to look around in all directions with no obstructions, and are made of molded, tinted plastic.



AQUAZIP MOTOR for swimmers (left) straps onto your back and can propel you through the water at twice the speed of a champion swimmer. Designed by Aquazip Ltd., Norwich, England, primarily as a life-saving device, it can also be used just for fun. It's powered by a 3-hp gasoline engine which is started by pulling a rope, and power is controlled by a hand-held throttle. You steer Aquazip by positioning your hands and feet.

ATOMIC ENERGY STUDIES FOR THE BLIND are now possible because of a series of books (right) printed in braille. Nuclear energy and its peaceful applications are discussed in the books published by the Atomic Energy Commission in conjunction with the American Printing House for the Blind in Louisville, Ky. The series is called *Understanding the Atom*. Nuclear topics, terms, diagrams and illustrations are all printed in raised lines or braille, a reading technique which uses sense of touch. Books are available at a nominal price by writing to the American Printing House for the Blind.

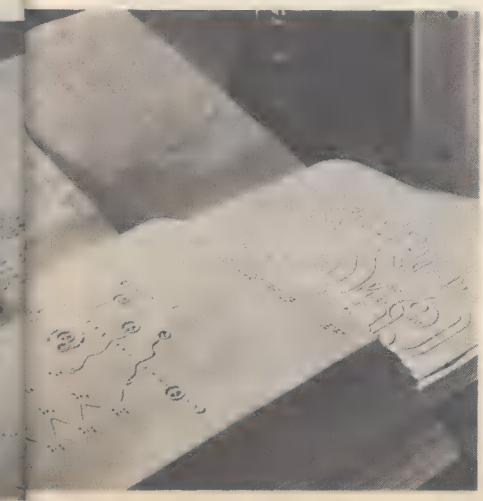
JOGGING CRAZE MARCHES ON with this latest of the indoor jogging machines (below). Central Quality Industries, Polo, Ill., thinks that "logging daily jogging" is important to the serious exercise buff so they've come up with the Slim-Master Electronic Jogger. Electronic impulses from the rubber mat under the runner's feet register his pace while a mechanical timer lets him know how far he's traveled. A good reason to stay inside on a rainy day.

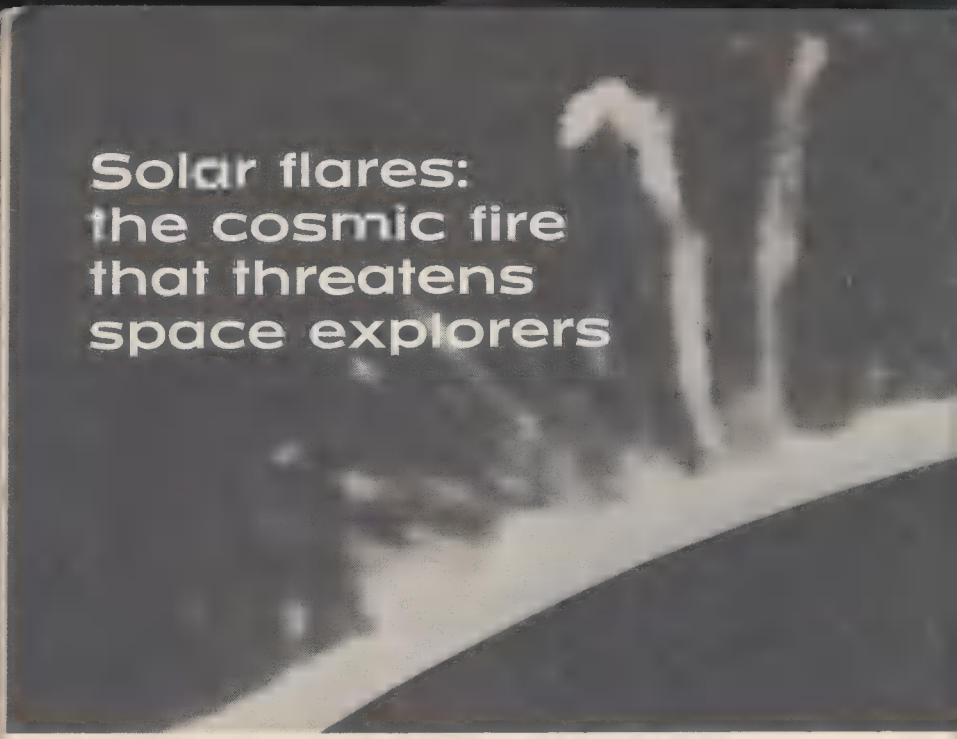
UPI

GERM-PROOF TEMPERATURE-TAKER (above) assures that germs will not be spread from patient to patient as is the possibility with ordinary thermometers. Called "Temprobe" by its developers, the Computer Diode Corp., the device reaches the patient's temperature in more or less the conventional way. The probe is then inserted into an electronic heat-sensing device which registers the temperature. Probe is then simply thrown away.

JUNIOR ASTRONAUT SUITS for the very young (below) may not replace the good, old cowboy suit, but it's sure to be a big favorite. The moon suits are by Somersault, Inc. of New York City. They are approximate copies of the outfits worn by American astronauts. The helmets have simulated headphones and transmitters. These two children were photographed in front of the moon mural at the Hayden Planetarium, New York, New York.

BIPS





Solar flares: the cosmic fire that threatens space explorers

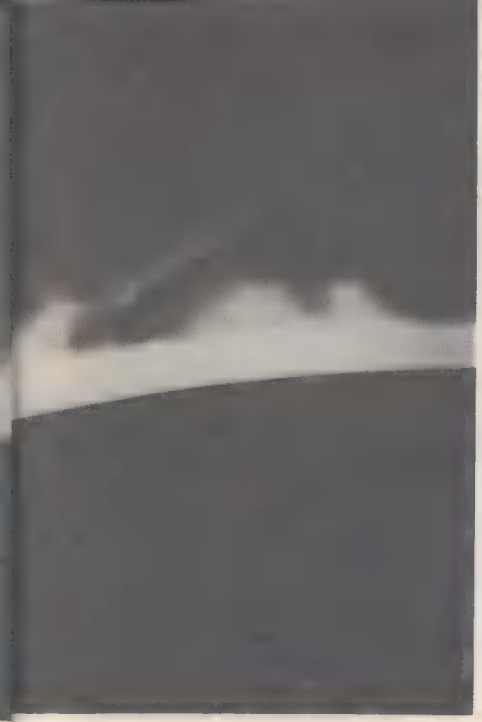
by Joann T. Temple

A GROUP OF SCIENTISTS in Boulder, Colorado, is keeping a close watch on the sun these days. With American astronauts in lunar space and walking on the unprotected surface of the moon, routine solar astronomy of the Environmental Science Services Administration gains new importance. Apollo 11 crewmen were fortunate in encountering minimal solar activity.

The huge burning mass of the sun, more than 300,000 times that of the earth, can have catastrophic weather. Flares—bright, massive tongues of hot solar plasma—erupt as far as half a million miles from the sun. The X rays, radio waves, light waves, electron clouds and destructive high-energy protons that often accompany the flares continue toward the earth.

The radiation from the high-energy protons has the potential to destroy anything from photographic film and sensitive electronic equipment to the cells and bones of an unshielded man. Consequently, accurate forecasting and immediate warnings of solar weather are extremely important d u r i n g manned space flights. Astronauts o u t s i d e their spacecraft would have virtually no protection from the lethal radiation that can follow a solar flare.

Robert Doeker, chief of ESSA's Space Disturbance Forecast Center in Boulder, stresses the point that not all flares produce the lethal proton showers. He says: "Protons, which are the chief hazard of solar flares, are relatively infrequent. Solar activity goes through a regular cycle, reaching ■ peak of activity every 11 years. During the past cycle, we de-



Solar flares erupt as far as half a million miles from the sun, often emitting X rays, radio waves and destructive high-energy protons. Because radiation from proton showers could be fatal to astronauts, ESSA, NASA, the U.S.A.F. are keeping close tabs on the sun.

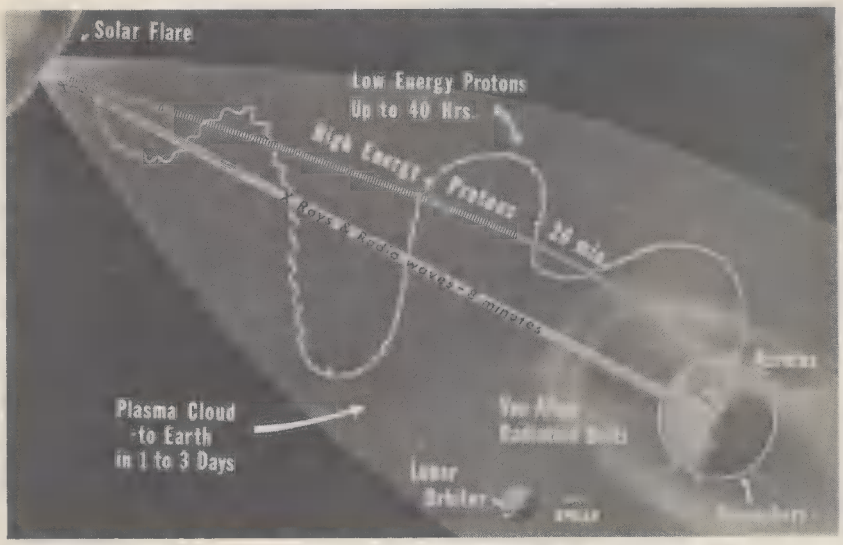
tected protons in only 40 of some 2,000 total flares. However, this year is the cyclical peak and the sun has been quite active. Such an active year as this could produce as many as eight proton showers."

ESSA scientists have learned to know each changing phase of the sun. They keep a particular watch on sunspots because of an apparently close relationship between these ever-changing dark spots on the sun's surface and the sudden, fierce brightenings that herald a flare (see "Sunspots," *Science Digest*, Dec. 1968, p. 82). ESSA's routine job in the Space Disturbance Forecast Center is to forecast solar weather for interested customers.

In one way or another, many people besides astronauts are affected by solar weather. When the earth is the direct target of a solar flare, a magnetic storm will soon occur on earth. During such a storm, high-frequency radio communications and long-distance cable systems can be disrupted for hours at a time. Knowing that the probable cause is interference from the sun, communications companies do not waste a great deal of time, talent and money looking for something wrong in their own systems. Extreme solar flares can even interfere with long-distance power transmission lines in high latitudes causing huge power surges which trigger an automatic safety shutdown. This could leave communities without electric power until corrective actions are taken.

All these solar effects are felt on the earth despite our thick atmosphere and a strong magnetic field which filter out most of the sun's radiations. A man on the surface of the moon has neither an atmosphere nor a magnetic barrier for protection.

During manned flights, ESSA, NASA and the U.S. Air Force merge all their solar facilities for the mission. Seven solar observatories around the world comprise a NASA project called SPAN for Solar Particle Alert Network. Span observatories are located in Houston, Boulder, the Canary Islands, Carnarvon and Culgoora, Australia, Hawaii and Tehran. The observatories at Boulder and Culgoora are operated by ESSA, and the Hawaiian and Iran observatories are operated by the U.S. Air Force. This global ring of observa-



Artist's conception of effects of solar flare shows how sun's emissions disrupt the magnetosphere and ionosphere, even interfering with long-distance communications, space photography.

tories assures that the sun's ever-changing face will be under scientific observations 24 hours a day. Scientists from Boulder's ESSA Research Laboratories serve as solar observers at two of the NASA stations, Canary and Carnarvon.

Should a fire erupt, one of the seven SPAN stations sees it immediately. "Immediately" in terms of the astronomical distances involved means within eight minutes, the time it takes for light to travel the vast distance from the sun to the earth. Getting this initial alert from a SPAN station to the NASA mission director in Houston is a complex process and Boulder's Space Disturbance Forecast Center must operate around-the-clock to assist in this.

If a flare occurs during Colorado's daylight hours, the first person to see it would be Joseph A. Sutorik. He tends an optical telescope atop ESSA's laboratory in Boulder. This scope tracks and photographs the sun continuously while Sutorik makes visual observations and maps sunspot changes. When Sutorik sees a sunspot begin to brighten, he alerts the Space Disturbance Forecast Center downstairs. There scientists cluster around the remote TV screen leading from Sutorik's telescope and, if the flare develops, it is logged in and a SDFC forecaster takes over.

He quickly analyzes the past history of the flaring portion of the sun, makes a tentative judgment of the magnitude and probable results of the flare and decides whether others need to know about it. If so, he teletypes details of the solar disturbance including information from ground stations on neutrons, protons and ionospheric data via a special solar

data teletype communications system. This alert on a flare, with scientific details, reaches the agencies concerned within two minutes. During Apollo missions, the forecaster picks up a "hot-line" phone and gives a fast verbal summary to the Space Environment Console in the NASA's Mission Control Center. A team of NASA personnel composed of space physicists, medical doctors and flight controllers are involved in space environment decisions at NASA Houston.

If this group suspects no problem to the Apollo mission from the solar flare, the ESSA information never leaves their console. If, however, they suspect that the astronauts may be in danger as a result of the sun's most recent action, they will relay the Boulder information and their own warning directly to NASA's flight surgeon.

The flight surgeon and the mission director must then decide what, if any, evasive action to take. They could, for example, call for an immediate change in the mission. An astronaut prospecting on the lunar surface might be ordered back to the shelter of his lunar lander. And, if the flare seemed to be releasing a really excessive amount of ionizing protons, NASA could conceivably tell their lunar explorers to end the mission and get back to the even greater safety of the more adequately shielded Apollo command and service modules orbiting the moon.

The logic of this complex warning system for solar flares rests on the fact that it usually takes at least six and sometimes as much as 12 hours for significant amounts of radiation from a flare to cover the 90-odd million miles between the sun and a lunar astronaut. Within four hours of a flare, space physics consultants and solar astronomers should be able to gather enough optical, radio and proton data for the NASA medical staff to accurately evaluate the hazard to the astronauts.

In addition to special alerts or warnings, NASA receives "space weather" information from the ESSA/SDFC on a routine basis four times a day just like other customers. The space environment console at Houston also gets solar data from a number of satellites such as Pioneers, Interplanetary Monitoring Platforms, Applications Technology Satellites, VELA and SOLRAD. The astronauts themselves are instrumented with radiation detectors which report individual radiation dose rates back to the space environment console in Houston every three or four hours.

Sun behavior erratic

ESSA solar astronomer, Patrick S. McIntosh, points out that solar prediction is not easy since, apart from its unexplained 11-year cycle, the sun refuses to behave with easily defined logic. At times complex clusters of sunspots are accompanied by interacting magnetic fields that may lead to flares. Prominences or filaments appear head-on viewed from the earth as dark lines which often accompany sunspots. They represent a region of the solar surface where the vertical magnetic field is zero and more flares seem to occur along this magnetically neutral line.

Flares can erupt continuously from the same region for anywhere from two to four hours. The largest flares extend over as much as two billion square miles of the sun's surface—

that is, ten times the surface of the entire earth.

ESSA forecasters attempt to categorize flares by their hazards and potential effects rather than by size. McIntosh explains that a class C flare, regardless of size, is relatively unimportant because it generates neither radio noise nor significant X rays. A class M flare is more significant and describes a solar event capable of producing some terrestrial effects such as a short sudden ionospheric disturbance or a minor solar radio noise event. A class X flare can wipe out communications in some areas of the earth for more than four hours and shower the space near earth with energetic protons.

Communications blackouts are most frequent over the earth's polar caps where magnetic lines of force converge. Most of the electrically charged particles from the sun are trapped by the earth's magnetic field lines which extend some 40,000 to 60,000 miles out into space. As the solar particles continue toward our atmosphere, they actually spiral downward around a magnetic line. Thus, most of them arrive at the north or south pole, disrupt communications and cause the colorful aurora or "northern lights."

Although scientists know that flares cause auroras, they do not know exactly whether particles from the flare itself are finding their way into the atmosphere or whether the flare alters the earth's own space environment so that other extra-terrestrial particles from space near earth enter our atmosphere.

In either case, solar particles pass easily through the rarified upper atmosphere until, 250 miles above earth, they begin to encounter more closely spaced atoms and molecules.

When high-energy solar particles collide with atmospheric constituents the northern lights begin. The bombarded atoms and molecules of the ionosphere lose electrons and absorb extra energy, a process called ionization and excitation. The ions, now in an excited state, get rid of their excess energy by emitting light—the brilliant and colorful aurora which usually begins about 30 hours after a major solar flare. The traditional auroras are caused by solar particles with relatively low energies. These particles, which collide with atmospheric constituents and are finally stopped at about a 60-mile altitude, produce auroras visible over a large area. Obviously, the best viewing is in the northern states; however, auroras are occasionally visible from the south and have been seen on extremely rare occasions from the equatorial regions.

A very-high-energy proton flare causes a peculiar aurora which is confined largely to the region of the polar caps. The high energy particles delve deeper into the atmosphere before they are stopped by collisions.

ESSA's solar forecasters stay on the alert for proton flares all the time, but, while Apollo crews are exploring the moon, the watch for solar hazards is magnified into even more intensive, world-wide effort of watching the nearest star, our sun. ■

For further reading

LIGHT AND ELECTRICITY IN THE ATMOSPHERE. *Hal Hellman. Holiday House. 1968.*

WORLDS AROUND THE SUN. *Lee Edson. American Heritage in collaboration with the Smithsonian Institution. 1969.*

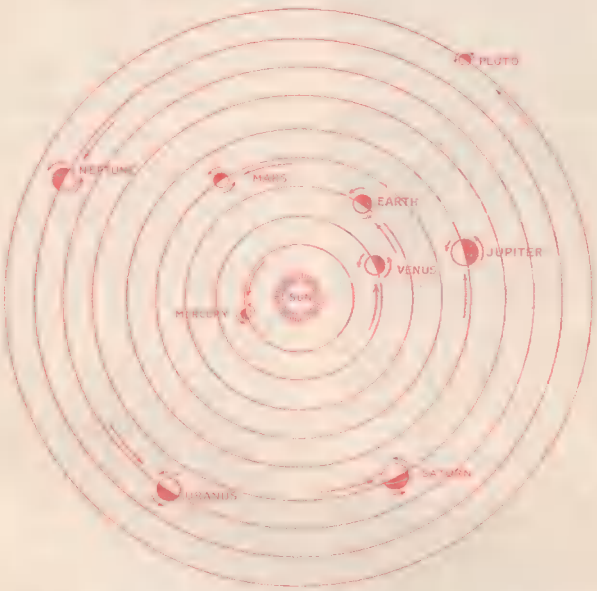


Diagram of solar system shows the planets' orbits and their relationship to each other. The grand tour would include 3 or 4 planets.

Grand tour of outer planets

A space scientist in California is planning a "Grand Tour" with an itinerary to include the most distant bodies in our solar system.

Dr. James E. Long of the Jet Propulsion Laboratory says that a rare lineup of the outer planets of our solar system from 1976 through 1980 makes that period a prime one for a tour of at least three distant planets. He suggests a four-planet tour of Jupiter, Saturn, Uranus and Neptune, or a three-planet tour of Jupiter, Uranus and Neptune. Another three-planet tour would take in Jupiter, Saturn and Pluto. None of the missions would be manned.

By touring a number of planets when the alignment is right, a spacecraft could take advantage of the gravity perturbation during a close approach to one planet to boost it

enough to reach planets unattainable with the original thrust, Dr. Long explains. The craft would use less energy visiting three or four planets during the 1976-80 period than it would reaching them via direct flight at another time. All the proposed tours would be "flybys" in which the craft would reconnoiter the planets for data and lay the groundwork for later missions.

Dr. Long points out in *Astronautics and Aeronautics* that present day space technology can provide a good base for developing a craft capable of reaching the outer planets, but that "significant" improvements would be needed. During its interplanetary cruise, the craft would be subject to environmental hazards not encountered on previous space flights. Among them: greatly decreased solar energy that would eliminate the use of present solar power concepts; the impact of particles in the asteroid belt big enough to do structural damage, and the intense radiation belts near Jupiter.

The outer planet spacecraft would have to operate 8 to 11 years without full-time ground support, according to Dr. Long. Other requirements would be a stable platform for pointing instruments at the planets, a trajectory-correction system that would take the craft from planet to planet, and enough versatility to operate successfully in a number of different environments, some of them unknown. The baggage would be an instrument load weighing a minimum of 80 pounds.

Can a craft be designed by 1976 that can do the job? "The challenges greatly exceed any mission proposed to date," declares Long. "Yet, present-day experience and a rapidly developing technology give space planners high confidence that such missions can be done."

Artificial skin for patients who have large parts of their skin burned is being developed at Southwest Research Institute. The "skin" is composed of synthetic polymers of amino acids and can be steam sterilized at 270°C. for long periods of time, lessening infections.

Marmes Man is 10,000

It's official—Marmes Man, whose remains were found in a cave in Washington state in 1965, is 10,000 years old. Preliminary estimates of the age of skull fragments, charcoal and decayed vegetation in the bottom layer of the site in southeastern Washington indicated the 10,000 year date, but confirmation awaited radiocarbon dating. The analysis shows the ages of the samples to be 9,840 years old, plus or minus 300 years. To cross-check results, deposits overlying Marmes Man and

mollusks eaten and discarded on the cave floor were carbon dated, too. They are between 8,000 and 10,000 years old.

The Marmes site is now in danger of being flooded by water backing up behind Lower Monumental Dam on the Snake River in Washington. A levee built to protect it from the water proved ineffective this winter.

Big animals sleep best

Man has lost some of the animal's ability to screen out visual and auditory disturbances when asleep, says Heini Hediger of the Zurich Zoological Gardens. He points out that many mammals not only close their eyes when they sleep but cover them with their paws or tail. Animals with particularly sensitive ears, like the bush baby and the big-eared bat, sleep with their outer ears folded.

A "filter" in the animal nervous system seems to distinguish between harmless and dangerous stimuli for the sleeping animal. A circus elephant, for example, will not wake up even if another elephant's leg is rested on its head, but it will rouse immediately if it hears the slightest metallic sound.

Soundest sleepers are large animals, particularly predators with little to fear from other creatures, Hediger notes. The champion sleeper in this class is probably the fierce sloth bear of India. Animals with safe dens like the fox, or holes like the mouse, also sleep well. If animals have no safe place to sleep, they may take turns sleeping. In Africa, part of a zebra herd reclines on the ground while the rest of the herd stays awake.

An animal may solve the sleep problem by staying awake all the time, or by sleeping only for brief periods. The solitary antelope is thought never to sleep and deer apparently sleep only a few minutes at a time, but very deeply.

Pictorial Parade

Baby elephant at Chessington Zoo in England insists on eating only bread and milk instead of hay, oats, vegetables and other elephant-type foods. She's just 21 months old and her daily diet is 75 bread rolls, 12 currant buns, 12 pints of milk—and 4 apples for dessert.

Feverish trees are sick

Trees, like people, seem to have higher temperatures when they're sick, a fact which the U.S. Forest Service is putting to good use. A forester with a helicopter is flying over Douglas fir forests in Washington and Oregon with a heat sensing device that can pick up the infra-red rays emitted by sick trees. A picture of the tree and its temperature both appear on a TV monitor, where they're recorded for further study. What makes a sick tree hot? Possibly its deteriorated root structure has a

reduced capacity to absorb moisture for use throughout the tree. One peculiarity of sick trees: their temperature is highest in the morning.

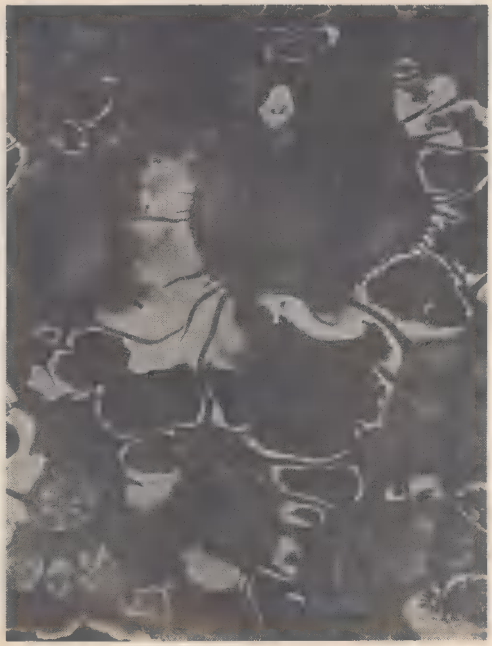
California=New Zealand

California and New Zealand, two land masses separated by more than 6,000 miles of Pacific Ocean, are mirror images of each other in size and some other aspects, says Trevor Hatherton of New Zealand's Department of Scientific and Industrial Research in Wellington. When Dr. Hatherton superimposed a mirror image of a two-dimensional map of California on a map of New Zealand, he found them almost identical.

California's ultramafic belt, an area low in silica and rich in igneous rock, follows New Zealand's ultramafic belt for a distance of more than 300 miles. The Sutter Buttes of California are much like those of the Whareorino and Orangiwhao volcanoes of New Zealand. Cenozoic and recent volcanic activity that has occurred in northern California has also occurred in the center and northwestern part of North Island, New Zealand. On the superimposed map, there is a geothermal electric generating station in California only 31 miles from one in North Island.

The only point of geologic disagreement is that the San Andreas fault on the face of California runs in the opposite direction of the Alpine Fault of New Zealand, although both faults are in the same area when the maps are superimposed.

Dr. Hatherton, whose findings are reported in *The Sciences*, thinks that



Inadvertent art is what they're calling the results of a heat test on a 16-gauge steel door, and it even managed to get into an art show. They were really testing the fire resistance of an elevator door at Ohio State University, but somebody saw ■ as "art."

the striking similarities in the two areas suggest "simple, regular physical forces at work at the edges of the continents." One such force might be the spreading of the floor of the Pacific Ocean. A theory suggests that the continents around the Atlantic Ocean separated from a single land mass when a motion deep within the earth forced matter to well up along the mid-Atlantic ridges and push outward against the continental margins (see Science Month, *Science Digest*, May 1969). There are several similar ridges in the Pacific.

Coyotes roam in Florida

The coyote, a relative newcomer to Florida, has been killing livestock in Polk County and local ranchers are riled up. Recently, a group of them organized a coyote hunt and captured two pups; the parents eluded the ranchers and their fox hounds. A male and female coyote were introduced into the central Florida area in 1950 by local fox hunters to give their dogs a new hunting experience. The pair apparently spawned several score more which recently began killing lambs, goats and calves. A coyote (*Canis latrans*) is a little smaller than a wolf, has a thinner snout and normally carries its tail down when it runs; a wolf carries his tail up. In recent years the adaptable coyote has been greatly extending its range and is now found from Alaska to Central America and east to New York.

Stag's horn toothpowder

A thousand generations of mankind have devised all sorts of ways to save their teeth and keep their mouths clean, according to WaterPik, a firm that sells a modern device that cleans the teeth with jets of water. The ancient Egyptians and Greeks thought ivy, a plant sacred to the sun god, could cure toothache. Chinese physicians of 3,500 years ago treated dental infections by applying a sharp needle, not to the teeth, but to the elbow to promote the "equilibrium of organic forces." The Romans used special salves to clean their teeth with wooden sticks and powders made out of burned stag's horns. To strengthen the gums, they favored bay leaves and myrrh. The ancient Hebrews rubbed the ashes of burned unripe olive pits on their gums to treat pyorrhea—an ailment they blamed on eating fish fried in leftover oil.

First mongoloid chimp

The first subhuman primate known to have the major features of mongolism is the object of intense research at Atlanta's Yerkes Regional Primate Research Center, reports *Medical World News*. It's hard to tell whether young Jama's face is "mongoloid," but her eyes definitely have the characteristic mongoloid fold. Only half as big as chimps her age, she takes twice as long to reach the various stages of development. Jama's condition was discovered during a test that indicated she had an extra chromosome. Since such tests aren't ordinarily given to chimps outside Yerkes, scientists there think other mongoloid chimps exist. They will concentrate on raising Jama to sexual maturity so she can bear offspring and there will be eventually a population of mongoloid chimps to study. ■

Photos American Museum of Natural History

Reconstruction of head and skull of a Sinanthropus woman is done by Dr. Franz Weidenreich.

The secrets of China's ancient men

Choukoutien, a remote limestone cliff 30 miles south of Peking, was the site of the beginning of paleontology's strangest story. Who were China's prehistoric men?

by Daniel Cohen

SOME 400,000 years ago a group of short, heavy-browed, flat-faced men butchered about 40 of their friends or neighbors, ate them and dumped their clean-picked bones into a limestone cave near what is now Peking, China.

These ancient cannibals had unknowingly provided modern man with one of the greatest finds in paleontological history. The remains of only a tiny percentage of living creatures are preserved, so fossils of *any* kind are rare enough. Fossil remains of early man are so rare and valuable that a jawbone, a skullcap or even a single tooth is considered a treasure. The fossil remains of 40 prehistoric men is the scientific equivalent of a king's ransom.

The find at Choukoutien, or Chou Gate Inn, a limestone cliff 30 miles south of Peking, was the greatest single find of fossil men anywhere.

Like all great scientific discoveries, this one raised more questions than it answered. For some this discovery seemed to shed new light on the problem of how the different races began. Others strongly disagreed. This controversy seemed to be almost solved until 1966.

In that year, as part of Chairman Mao's "Great Cultural Revolution" the Chinese people were encouraged to turn their backs on the past. Chinese archaeologists and paleontologists who had been making great strides had to stop working. So some of the most intriguing puzzles of the past will have to remain unsolved for a while.

One of these puzzles concerns the Choukoutien find. We call the man unearthed there Peking Man. An air of mystery has surrounded Peking Man from the moment his existence was first suspected.

That moment came in 1903 when a German scientist, K. A. Heberer, was shopping in a Peking drugstore. Chinese druggists of the time sold ground-up "dragon teeth" as a cure for practically anything. These "dragon teeth" were usually the fossilized teeth of long dead animals.

The source of the "dragon teeth" was traced to Choukoutien. Western scientists were anxious to go to China and start digging, but Chinese distrust of foreigners is not new, and only a few scientists were able to do any excavating. The difficulties were further complicated by the unsettled political situation. Roving armies of bandits would often invade the campsite. It was not until 1927 that another human tooth was found at Choukoutien. Davidson Black, a Canadian paleontologist who was teaching at Peking, said the tooth came from a type of man he named *Sinanthropus pekinensis.*

For the next ten years the huge cave at Choukoutien was excavated by a group of international scientists. There was the Chinese Dr. P'ei Wen-Chung, the French priest and philosopher Père Teilhard de Chardin and Dr. Black. Discovery followed discovery, and by 1934, Dr. Black, worn out from his labors, died. His place was taken by an Austrian paleontologist, Franz Weidenreich. Not only were the shattered remains of the forty victims found (the cannibals had been very thorough, even splitting some of the long bones to get at the marrow) but there was also evidence of fires, the first known human use of fire, and some crude but recognizable tools.

Disappearing bones

Weidenreich decided to have exact casts made of all the remains. War was raging in the Orient and the Japanese were extending their occupation of China. The Chinese government gave the Peking Man bones to Americans in Peking for safe keeping. The bones were to be put aboard the *U.S.S. President Harrison* for transfer to the United States. On their way to the ship they disappeared. No one knows what happened to them. The Americans blame the Japanese, and the Chinese Communists blame the Americans. The casts and a single tooth that had been sent to Sweden are all that remain of the original find.

Weidenreich had brought the casts to the U.S. when war broke out in China. He continued to study them and the reports that his colleagues had written about the discovery. He

The digging site at Choukoutien as it looked in 1936. China's cultural revolution has stopped further investigation at the site unfortunately.

came to a rather startling conclusion. Peking Man, Weidenreich said, resembled modern Chinese, indeed all Mongoloids in a number of important ways. He suggested that Peking Man was ancestral to the Mongoloids.

This suggestion was not enthusiastically received by most other scientists. It would have meant that at least two lines of men, one the Mongoloids, and the other everyone else, had diverged hundreds of thousands of years ago, and had evolved in parallel ways in regards to the development of intelligence, culture and all the other traits that we think of as "modern" or even "human." The most widely held scientific view was, and still is, that all racial differences are fairly recent evolutionary developments. Man, the majority opinion holds, first evolved into fully modern form and then racial differences began to appear.

A major problem with Weidenreich's theory was that there were no intermediary fossils linking Peking Man with the modern Mongoloids. Actually Weidenreich himself had examined some possible intermediaries at Choukoutien, but had failed to recognize them. In another cave higher in the cliffs the scientists had found the remains of seven skeletons. This cave had not existed in Peking Man's day and the skeletons were much more recent, perhaps only 50,000 years old. Three of the seven skeletons, a man and two women, were fairly complete, and the scientists were able to get a good idea of how they died. Once again, it was apparent that Choukoutien had

been the scene of violence. This time, however, there was no attendant cannibalism. The man's skull had been pierced by an arrow, the women both had their skulls crushed from the side. The head-smashing was so thorough, and the bones so disarranged that Weidenreich tentatively identified one of the women as a Melanesian and the other as an Eskimo. The man, he said, might be an Ainu (an ancient race of apparently Caucasoid people who lived in Japan). Re-examination of the casts and notes on the excavation have led scientists to conclude that the upper cave skulls from Choukoutien are not a mixture of races, but are all Mongoloid, with perhaps a few characteristics of Peking Man.

But still a gap of hundreds of thousands of years, and a great deal of evolution lay between the fossils of Peking Man and those from the upper cave at Choukoutien. World War II and the Chinese revolution that followed, ended all excavation. After 1945 excavations were resumed under Chinese direction.

The political isolation of China from the rest of the world made an exchange of information difficult and slow, but not impossible. News of discoveries in China found its way into Western scientific journals. Some teeth were found in 1954 at Ting-tsun in northern China, more teeth were found in a cave in Lungtung, a fragmentary skull was discovered by farmers in 1958 in Kwangtung Province and in the same year another jawbone of Peking Man himself was found at Choukoutien.

In a monumental study, *Origin of the Races*, written in 1962 by Carleton Coon, the author stated: "As late as 1955 it would have been risky to endorse Weidenreich's bold speculation that the Mongoloids of the world are descended, at least in part from *Sinanthropus* or similar populations of pre-sapiens. . . . So rapidly are new discoveries being made in China and also in Japan, that the risk is now on the other side." Coon believes that the remaining problems might well be resolved by the discoveries of the next few years.

Shortly after Coon wrote, the picture of ancient man in China became more complicated. In 1963-64 at Lant'ien, east-central Shensi Province, a jawbone and skull of a man who was apparently contemporary with Peking Man was unearthed. Lan-t'ien Man, as this discovery has been named, was more primitive than Peking Man—thicker skull, smaller brain case, etc. But one odd feature about Lan-t'ien Man was that his teeth have certain pecularities that are also evident among many modern Mongoloids—Eskimos, some American Indians and many Asians. What does this mean? Right now no one knows.

Another Chinese mystery

The search for the answer to yet another mystery of China's ancient past has also been cut off, tantalizingly close to a conclusion. This mystery also starts in a Chinese drugstore. In the early 1930s a Dutch paleontologist, G.H.R. von Koenigswald, was looking at the "dragon teeth" in a Hong Kong drugstore. He found one that looked like it had belonged to an ape. The tooth was badly worn and the roots were missing, but even from this fragment von Koenigswald realized that this was by far the largest ape

tooth that anyone had ever seen. The next year a second tooth was found in a drugstore, and the following year a third. Von Koenigswald named the creature to which these huge teeth had once belonged *Gigantopithecus blacki*, Black's giant ape, in honor of Davidson Black.

Von Koenigswald showed the teeth to Black's successor, Franz Weidenreich, who, with customary thoroughness, made casts of them. It was a good thing he did, for von Koenigswald and his collection disappeared into the confusion that engulfed wartime China. Back in America Weidenreich reexamined these casts and came to a conclusion even more startling than his theory about the relationship between Peking Man and the modern Mongoloids. These huge teeth, he said, belonged not to a giant ape, but to a giant man, "and should, therefore, have been named *Gigantanthropus* (giant man) and not *Gigantopithecus*."

Moreover, Weidenreich related these teeth to a large and undoubtedly human jawbone fragment that von Koenigswald had discovered in Java. Both the "Java Giant" and the "Chinese Giant," said Weidenreich, were direct ancestors of man.

Weidenreich could not say how large these ancient giants were, for large teeth and large jaws do not always mean large body size. But he estimated that the Chinese Giant was about twice as large as a male gorilla. The gorilla is the largest living primate (and aside from the Chinese Giant) the largest known primate that has ever lived. A large male gorilla will weigh 500 pounds.

Weidenreich's theory about man being descended from giants got even less support than his theory about Peking Man and the Mongoloids. He died before any further information about the Chinese Giant was discovered.

Between 1956 and 1958 Chinese scientists dug up three complete jaws of the creature from a cave in Kwangsi Province. They said the creature had lived earlier than Peking Man, but far too late in history to be the ancestor of Peking Man or any other branch of the human family. Besides, more complete evidence showed that the creature was definitely an ape, and that it was not as large a giant as first believed. The Chinese scientists estimated that *Gigantopithecus* was no larger than a large gorilla. It just had exceptionally large teeth.

End of mystery? Not completely. There are no known large apes in China today, but in 400 B.C. the philosopher Hsun-Tzu wrote about a man-sized ape that lived in the Yellow River Valley. As late as A.D. 200 man-sized apes were reported in Sin-Kiang Province near Tibet.

Many people, including a few respected scientists, have advanced the possibility that these stories, or *Gigantopithecus* itself, might in some way be related to the stories of the Abominable Snowman or Yeti. This is yet another puzzle that can only be solved in China. ■

For further reading

APES, GIANTS AND MAN. *Franz Weidenreich. University of Chicago Press. 1946.*

DRAGON BONES IN THE YELLOW EARTH. *James and Irving Crump. Dodd, Mead & Co. 1963.*

THE ORIGIN OF RACES. *Carleton S. Coon. Alfred A. Knopf, Publishing. 1968.*

Rubber giants of the underground

LIKE MONSTROUS CANNON BALLS shot through subterranean cannon, these giants rumble through 630 miles of oil pipeline. The 40-inch, 900-pound rubber balls travel through the pipelines in order to clean out salt water and sludge. "Capline" —the biggest underground crude oil pipeline in the U.S.— stretches from St. James, La., to Patoka, Ill.

The balls are put in the pipeline at the Louisiana terminal. On their ten-day journey they travel beneath both the Mississippi and the Ohio Rivers and under miles of swampland. There are 16 pumping stations en route—each controlled by computers.

The entire Capline pumping system is powered by electricity. The computers control the line and calculate the gallonage flowing through it. As the pump pushes the oil northwards from Louisiana, the balls (they fit into the pipe like pistons in a motor) are propelled through the line with pressurized oil flow. When the balls arrive in Patoka, they're taken out of the pipeline and transported by overland carrier back to Louisiana—ready for the next ten-day, 630-mile underground mission. ■

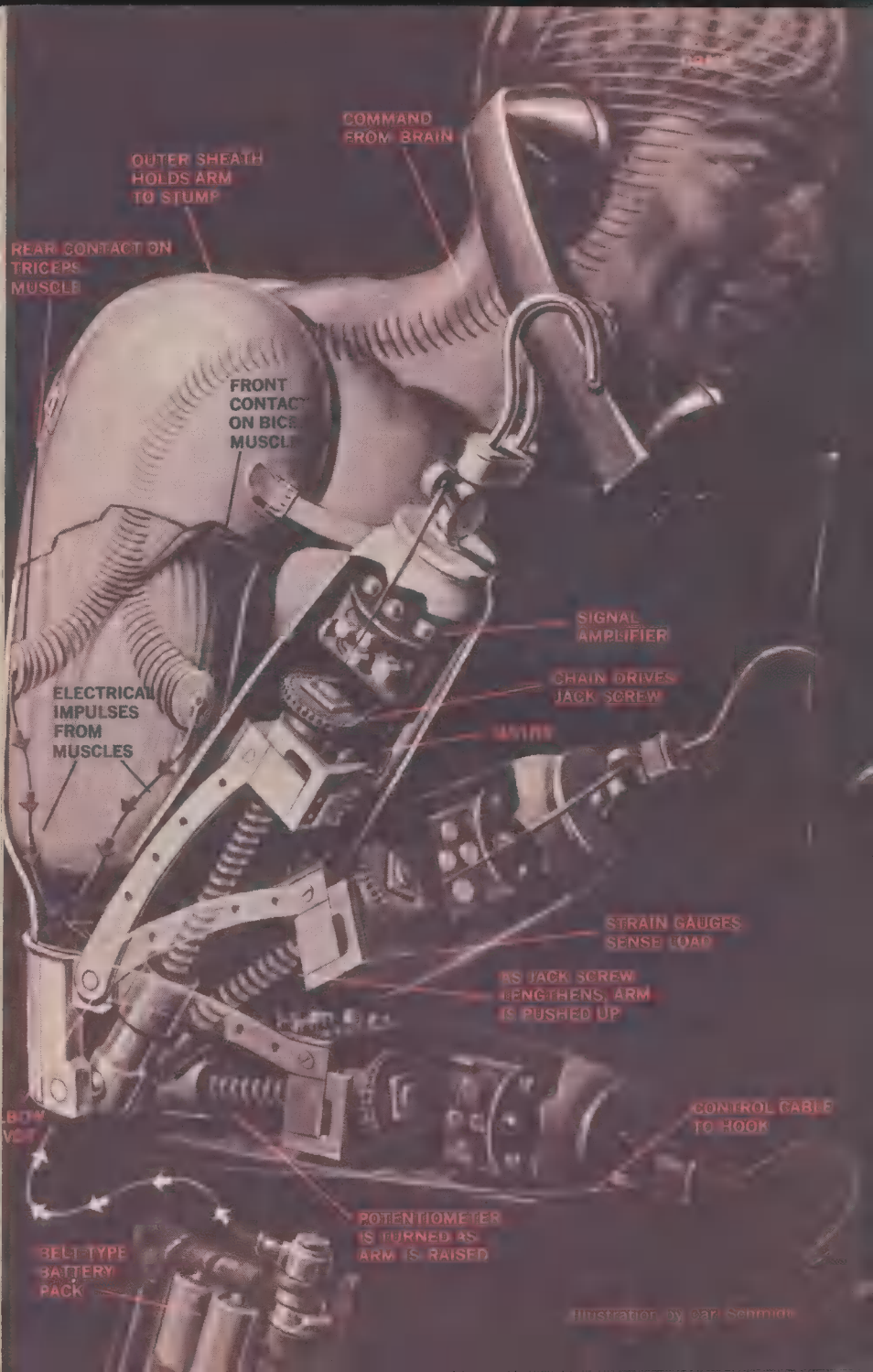

COMMAND FROM BRAIN
OUTER SHEATH HOLDS ARM TO STUMP
REAR CONTACT ON TRICEPS MUSCLE
FRONT CONTACT ON BICEPS MUSCLE
SIGNAL AMPLIFIER
CHAIN DRIVES JACK SCREW
ELECTRICAL IMPULSES FROM MUSCLES
STRAIN GAUGES SENSE LOAD
AS JACK SCREW LENGTHENS, ARM IS PUSHED UP
CONTROL CABLE TO HOOK
POTENTIOMETER IS TURNED AS ARM IS RAISED
BELT TYPE BATTERY PACK

Illustration by Carl Schmidt

Medical engineers: doctor/designers for tomorrow's people

by Arthur S. Freese

HOW IMPORTANT is bioengineering to you and your family? The answer is "unbelievably important," because its new techniques are rapidly overcoming "hopeless" disabilities and diseases which kill outright and cripple many more. Crippled people are learning to walk again, thanks to electrodes implanted in their muscles. Some blind are even learning to "see" by means of electrodes connected to their brain or appropriate nerves. The skin too has been used for "seeing." And there are even bioengineering devices which converse by telephone with computers.

Five- or ten-cent electrocardiograms are predicted for the foreseeable future, with other medical tests at costs to match. A double wristwatch has been invented which signals if your heart beats too fast or too slow. Balloons are being used to save the lives of victims of heart attacks. Electrical signals are being transmitted to the brains of monkeys to produce any desired behavior—and scientists talk of using this technique to help retarded children become self-sufficient.

All this is just a taste of what the near future has to offer—the fantastic new world of bioengineering. So new is all this that even those involved haven't settled on a name as yet: the field is also known as biophysics, biotechnology, biomedical

This man is using an artifical limb called the Boston Arm. Cutaway drawing shows how a screw jack arrangement raises arm like a car jack. Tiny motor turns screw according to electrical signals from muscles in the stump. Amputee can lift a cup of water and drink from it, answer the telephone, even lift 10 pounds. Weight is measured by strain gauges so that amputee can tell how heavy a load he is picking up. The Boston Arm is powered by a battery pack worn around the waist.

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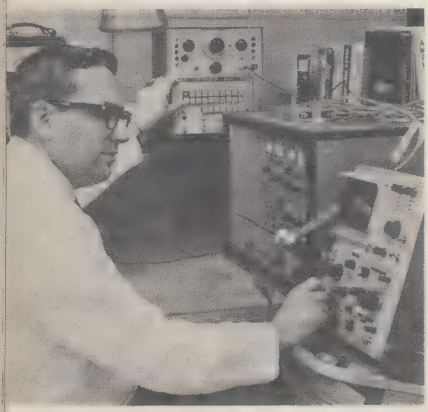

BIPS

Complex electronic machinery is assuming an ever-increasing share of the doctor's burden. Above, Seymour Ben-Zvi of the Downstate Medical Center in Brooklyn, N.Y. is working with an electromyograph used to record the response of a muscle to electric stimulation. At right this man is having his heart tested with an electrocardiograph (ECG) in a London health center which has an automated check-up program which uses a computer to keep track of records.

engineering and bioelectrics. And any instrument or device that's over a year old is considered earlier generation. Those in the field include engineers, physicians, biologists, physicists, chemists and mathematicians. Only a few years ago, no one would have believed that the December 1968 meeting of the American Society of Mechanical Engineers would listen to some two dozen papers whose content made them just as appropriate for a medical meeting as for an engineering one.

But what *is* bioengineering (the term most commonly used)? Seymour Ben-Zvi, director of scientific and medical instrumentation at New York City's Downstate Medical Center sees it as a concept rather than a specific field, a multi-disciplinary approach to medicine by the space age from whose technology it freely borrows. Once sciences entered the formerly sacred and restricted halls of medicine, a revolution took place in its practice—and we all have gained by it. The best way to explain bioengineering is to look at its accomplishments, for its limitations are those individuals set for themselves.

Unique in bioengineering are two of its earliest pioneers, the brothers Kantrowitz—Adrian the famous heart surgeon and Arthur the physicist and director of the Avco Everett Research Laboratory. It is the com-

(Continued on page 53.)

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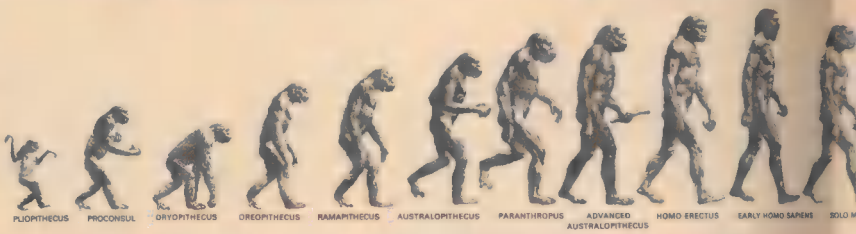

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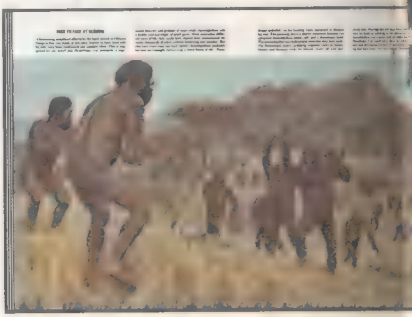
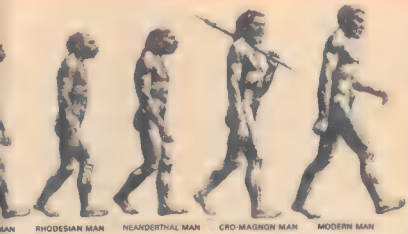


from tree-dweller to space-traveler



Actual size: 8½" x 11". 200 pages. Over 200 illustrations, photos and maps, many in full color.

Left, a Stone Age ax is used by experimenter to study its wear patterns. Right, Cro-Magnon man is correctly depicted as being tall and robust.

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bining of talents such as these that makes bioengineering the remarkable "concept" that it is. Now director of surgical services at New York City's Maimonides Hospital, Dr. Adrian Kantrowitz defined bioengineering as "the application of engineering devices to the treatment of human diseases." He adds, "The days of the amateur engineering we did when I was young are over. We're going to need the sophisticated brand of engineer coming out of the modern training programs in order to make the kind of progress in medicine we have to make."

Among the surgeon's major contributions have been an improved heart-lung machine and heart pacemakers. The brother team has electrically stimulated the major muscles of sitting and standing and enabled a completely paralyzed man to stand up and sit down.

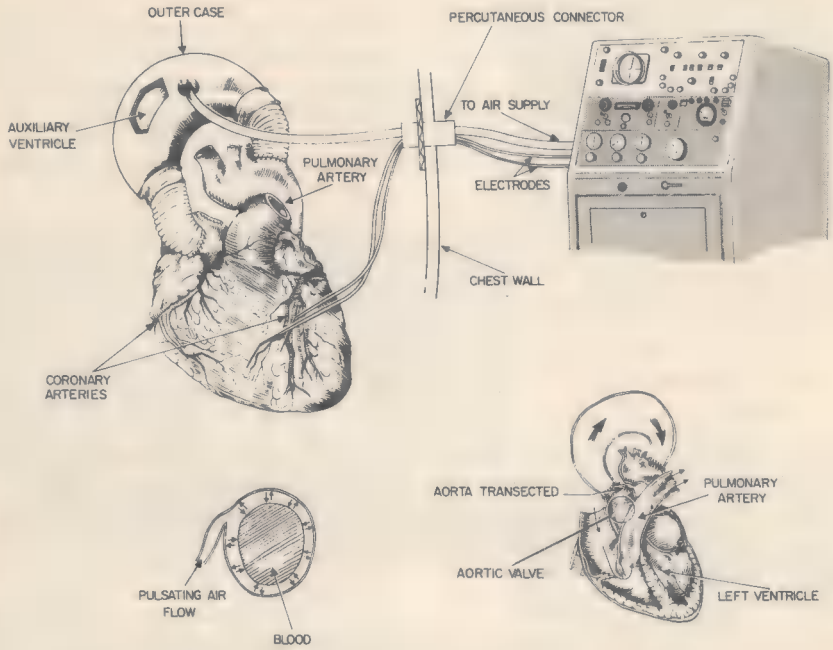
The brothers also developed an electrical urinary bladder stimulator for those who cannot empty their own bladders, an estimated 200,000 Americans. They developed and placed a tiny radio receiver, the size of a wrist watch, beneath the skin of the abdomen, then implanted two electrodes from it into the muscle of the bladder. A hand-held transmitter, the size of a flashlight, activated the receiver and made the bladder muscles contract to expel urine. However, Dr. Kantrowitz says it's now back in the laboratory for further development.

Adrian Kantrowitz's famous cardiovascular (heart and blood vessel) surgery today is a triumph of bioengineering. It has brought inestimable hope for 30,000 to 50,000 children born with heart defects each year in the United States. Only the development of the heart-lung machine, in which he joined, has made corrective surgery possible. The Kantrowitz brothers have also developed a heart-assist device—an air-driven pump which takes blood from the aorta as it leaves the heart and gives it an extra kick so that the heart's pumping action is enhanced—if the help is no longer needed, the pumping mechanism can be cut out and the device becomes merely an extra shunt through which the blood passes.

Promise of artificial heart

Adrian Kantrowitz is now working with his "phase-shift balloon pump," a device which has been used on 30 patients. These patients who have suffered shock from severe heart attacks have an 85 to 95 percent chance of dying, but Kantrowitz has reversed these odds with this new pump. Inserted through an artery in the leg, the device is snaked through to the aorta where a burst of helium can inflate the balloon and help drive the blood through the body, making it easier on the heart. The surgeon finds it also reduces the amount of damage to the heart in less severe attacks. Moreover, it's a simple technique which doesn't require a heart surgeon so that it can be used widely.

A complete artificial heart was recently used successfully for 63 hours in a human being by Dr. Denton Cooley of Houston. Artificial hearts have worked in animals for a week or so. However, Kantrowitz feels that in the future the artificial heart aids or replacements will prove of more value to more people than transplants which can only be done



CUT-AWAY OF OUTER CASE AND AUXILIARY VENTRICLE

Cardiac assist device (above) can be permanently implanted in the patient's chest. Developed by the famous Kantrowitz brothers, it is an air-driven pump which takes blood from the aorta as it leaves the heart and assists it so that the natural pumping action of the heart is enhanced. The pumping can be turned on or off as it is needed.

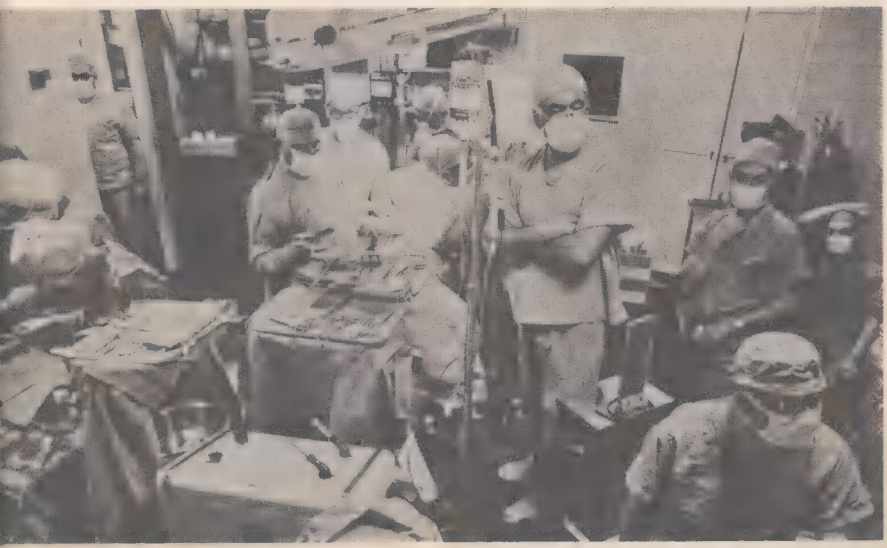
Auxiliary left ventricle (left) was also developed by the Kantrowitz brothers. It is used in cases of serious heart disease where the patient's own left ventricle is in great danger of failing. The device is implanted in the chest and attached to the heart as the drawing above shows. Synthetic fibers helped to make device possible.

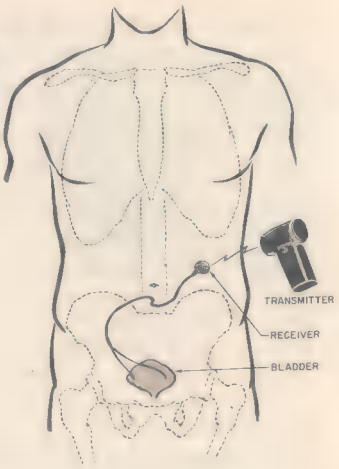
Operating room at right shows Drs. Adrian (left at operating table) and Arthur Kantrowitz (arms folded). They are in the midst of an operation to implant one of the auxiliary ventricles they developed. They are momentarily turned away from patient to observe his condition on an oscilloscographic recorder which indicates blood pressure, pulse, ECG.

in small numbers because of the many problems inherent in this technique. Dr. Michael E. DeBakey, famed heart surgeon of Houston's Baylor College of Medicine, agrees—in almost the same words.

Since cardiovascular diseases kill more Americans (over a million) than all other causes of death put together, it is not surprising that bioengineering should work hardest in this field. The Coronary Care Unit (CCU) is a hospital's specialized area devoted to care of serious heart attacks—an all electronic feat of bioengineering. The CCU contains electrocardiographs; electronic devices to check pulse rate, heart beat and rhythm, temperature, arterial and venous blood pressure and blood gases; heart defibrillators (to shock a wildly beating heart back to normal), meters for checking blood acid-alkali condition, positive pressure breathing apparatus, rotating tourniquets, hypothermia (cooling) equipment, electroencephalographs (for checking the brain); means of determining heart output, and pacemakers to bring a heart back to normal rate. There are oscilloscopes (like your TV picture tube) at the bedside to show the electrocardiogram and "slave" units how to do the same at a central nursing station. And new monitoring devices are being steadily added.

Proof of the life and death importance of bioengineering came from Dr. Jesse E. Edwards, president of the American Heart Association when he opened the 1968 Heart Fund Campaign. He pointed out that the CCU with its continuous monitoring of heart attack patients and alarm system for calling an emergency medical team can produce "the lifesaving equivalent of an estimated 50,000 successful heart transplants yearly." CCU improves the survival rate approximately 30 percent. Yet, of some 5,000 hospitals





Electronic bladder stimulator is used in cases where the patient is unable to expel urine. Device is implanted beneath the abdominal skin. It consists of a tiny disk-shaped receiver with two steel electrodes attached to detrusor muscle. There are no wires outside the skin. Transmitter is merely held over the implanted receiver.

for the acutely ill patient, only about 800 have coronary care units. He pointed out that the vast majority of the estimated quarter-of-a-million people who die from heart attacks in American hospitals annually don't get the monitoring and emergency service that modern bioengineering has made available.

One of the most exciting areas in bioengineering is computerization. In January, Dr. Leon Pordy, associate clinical professor of medicine at New York City's Mount Sinai School of Medicine, opened a new world of medicine for remote areas where the advantages of medical specialization rarely reach.

In West Virginia, patients used to wait as long as two weeks for their electrocardiograms to reach a cardiologist (a heart specialist) and be returned with a diagnosis. Dr. Pordy solved this problem by sending a two-and-a-half-foot-square cart to Princeton Memorial Hospital. The cart contains an electrocardiograph, magnetic tape and a device to convert the output to a signal which can be transmitted by phone to Mount Sinai's computer center in New York. The doctor in West Virginia can wait by his patient's bedside for an answer which comes back in about three minutes. Dr. Pordy, who has carried this set-up to Belgium and Switzerland, told me his computer has done thousands of these diagnoses; two other carts will permit this service to eventually reach some 40 locations within West Virginia. He particularly recalls an important official who became sick during the night while visiting the hospital. Just before discharge in the morning, a routine electrocardiogram was sent to Mount Sinai's computer. The diagnosis very likely saved the man's life for it revealed a serious heart attack. Instead of leaving, he was hospitalized for several weeks.

Dr. Cesar A. Caceres, U.S. Public Health Service Disease Control Program, insists that "in 10 years, the computer will have helped create a revolution in medicine." He predicts the cost of electrocardiograms falling to perhaps 5 or 10 cents, and the whole battery of medical and laboratory tests becoming economically available to all of us for the first time. The Public Health Service is said to be so sure of the value of computers that it is authorizing the spending of $10 million or so a year for research into the "life-saving" applications of these machines.

One electrical engineer hopes to

diagnose one type of cancer by telephone. He claims that by telephone a computer can pick up gross irregularities that develop in the speech pitch of people with vocal cord growths. The Cleveland Hearing and Speech Center is said to be working on another method of computer analysis of speech patterns—but they hope to diagnose developing neurological diseases by it. In fact, one doctor is quoted as predicting a decreased need for physicians themselves by the turn of the century. This seems only logical now that computers have begun to treat patients.

At the University of Southern California a system is being devised to link patients directly to the testing equipment for continuous measurement of changes in heart action, blood pressure, urine output and skin temperatures. When fully worked out, the system will automatically take corrective actions over the infusion of fluids and medication, control of heating and cooling devices, even control of pace-makers.

At the University of Alabama 342 patients who had open heart surgery are said to have spent their first 24 to 48 hours after surgery under the tender care of a monitoring and treating computer. The machine checks on blood pressure, heart rate, chest tube drainage, rectal temperature and urine output. *But,* it also analyzes the data, decides whether the patient needs certain fluids and then either delivers the amount or stops what he is getting.

A team of engineers hooked a man to a computer to process the electrical signals which the biceps and triceps muscles in his arm give off when they work (the same kind of signals the electrocardiograph picks up from the heart muscles). By placing electrodes on these arm muscles and using an oscilloscope to record the signals, the investigator could control the signal at will. Then came the utilization of this knowledge to build the "Boston Arm."

The major problem when an amputee loses an arm between elbow and shoulder is the operation of an artificial elbow. By simulating the problem with computers, a whole range of potential solutions were tried and discarded. Finally, in the summer of 1965, a trial device was built. The upper-arm amputee proved able in practice to control the artificial limb just as the computer had predicted.

Electronic arm

A team from Harvard Medical School and M.I.T. has produced this 2-pound, 1-ounce flesh-colored Fiberglas casing with its electronic wizardry—the user can "will" it to work just as he does his own. Taking the electrical signals off the muscles which would naturally do the job for his arm, the "arm" amplifies the signals and utilizes them so that the owner always knows where his "arm" is, how fast it's moving, even how heavy the weight in its "hand" is—with it he can lift a cup filled with water and drink from it, answer the telephone, move blocks, even lift ten pounds.

So great a hold has bioengineering taken with its promises for tomorrow that there are now more than 500 companies in the United States producing electronic medical equipment. One of the increasingly useful areas is telemetry. Medical helicopters and

ambulances are now being built to take advantage of NASA's work on monitoring our astronauts—they transmit electrocardiograms ahead to their hospital.

A telephone-telemetry systems developed at UCLA's Brain Research Institute transmits a patient's brain waves for its computer analysis. A pack the size of a small transistor radio is worn by the patient. Amplifying his brain waves and other electrical activity, a special radio then transmits them over the telephone to UCLA where they are recorded for its computer analysis. The person dials the special number and leaves the phone off the hook for a specified period. Meanwhile the patient is free to move about in his yard or house.

Even Zeppo Marx in on It

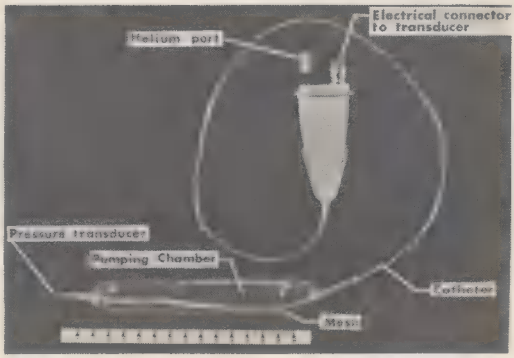
Even comedian Zeppo Marx has gotten a piece of the action in bioengineering. Along with an engineer he has patented a double wristwatch which checks on the wearer's heart. If something goes wrong, an alarm sounds. One watch is electric, and its switch is operated by the owner's pulse. For comparison, a conventional watch is worn on the same bracelet. The first or control watch keeps proper time at the wearer's normal pulse rate, whatever that may be. As long as this rate continues, the hour and minute hands of the two watches will point to the same time. But they are geared together in such a way that if they get out of alignment, an alarm sounds —indicating that the heartbeat is too fast or too slow. (This watch in *not* in production.)

But bioengineering doesn't always give bad news. The Mayo Clinic recently had a 17-year-old girl referred to them. She had a history of unexplained periods of extremely rapid heartbeats, and drugs had proven worthless. The Mayo physicians gave her a device small enough to fit neatly into a pocket—it contained an electrocardiograph, tape recorder, heart rate trigger, an alarm and batteries—and told her to turn it on during an attack. The next day the youngster had one of her attacks and later came in with its record. From this, and a few questions, the diagnosis was made—the normal reaction of any teen-ager to a history test. There was nothing wrong and never had been!

At Cambridge University a more serious use of bioengineering has stretched out to attack one of man's most devastating problems—blindness. Two investigators, Drs. G. S. Brindley and W. S. Lewin, inserted a sheet of electrodes beneath the skull of a blind woman, 80 electrodes contacting that part of her brain which "sees," where the nerve of sight ends. By stimulating these electrodes, the woman had the sensation of "seeing" light. Meanwhile at the National University of Mexico, Dr. Armando del Campo has devised ways to stimulate the brain so that blind patients can avoid trees, lamp posts and objects on the ground. Dr. Del Campo uses photosensitive agents which convert light into electrical signals to reach the brain through a non-optical nerve. But all these devices are still experimental.

In addition, Dr. Paul Bach-y-Rita and Carter C. Collins, at San Francisco's University of the Pacific, are using a TV camera to break down a picture into electrical impulses which

Phase-shift balloon pump developed by Adrian Kantrowitz is inserted through an artery in the leg (right) and is snaked through to the aorta. The balloon can be inflated with a burst of helium and thus help push the blood through the body. The device has been used on 30 patients who suffered shock from very severe heart attacks.



activate stimulators on the the observer's back—he then "sees" with his skin as children do in play when they trace letters on each other's hands. After a half-day's training, it was possible for congenitally blind people to recognize objects and their distance relationship to each other. Obviously this has a long way to go before any of these will be of practical help to anyone, but there is now some hope for the near future.

This same technique of using electrodes in contact with the brain has made it possible to control monkeys' behavior by stimulating different areas of the brain. This may yet be of help in retarded children, according to Dr. Bryan Robinson of the Yerkes Regional Primate Research Center in Atlanta, Ga. But here, too, bioengineering is far in advance of our ability to utilize its findings.

This new world of hope for mankind has accomplished so much and is moving so fast that no summary is even possible—only the recognition that the future will be much more exciting than the past. ■

For further reading

"The Amazing Boston Arm." Arthur S. Freese. POPULAR MECHANICS. March 1969. pps. 102-106.

"The American Engineers." BIOMEDICAL ENGINEERING. February 1968. pps. 18-20.

"Electronic Eyes for the Blind." THE SCIENCES. November 1968. pps. 20-21.

"Electronics in Medicine." MEDICAL WORLD NEWS. March 21, 1969.

MASS TRANSPORTATION INNOVATION (above) called Bay Area Rapid Transit system (BART) will be controlled by a massive control center display panel system developed by Transistor Electronics Corp. (TEC), Minneapolis, Minn. BART is being constructed in the San Francisco area and will require only three operators to monitor train control for the entire 75-mile network. The high-speed rail network will operate at speeds to 80 mph.

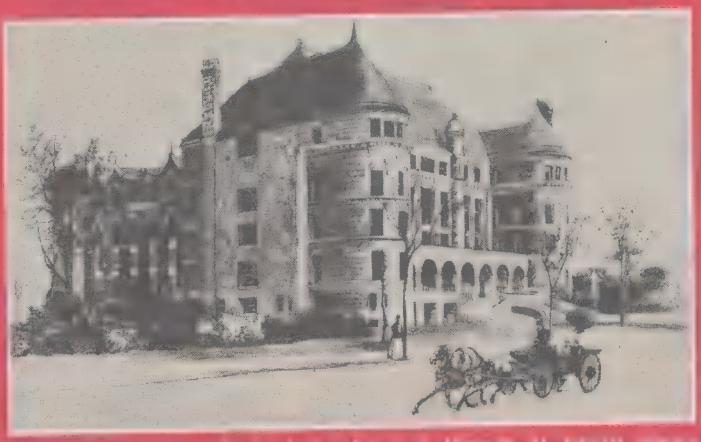
GLITTERING MOUND OF CRYSTALS (below) is valued at $340 an ounce, which makes it a material more precious than gold. Called Borazon Type II cubic boron nitride, it is a manufactured material which is not found in nature and is expected to be most useful as an abrasive for precision metalworking applications. The crystals are made from the raw material hexagonal boron nitride, the white powder in the vial the woman is holding.

GIANT INFLATED GREENHOUSE above can be assembled in a small fraction of the time it takes to build an ordinary greenhouse and costs about one-eighth as much. Developed by the Goodyear Tire & Rubber Co., Akron, Ohio, the plastic enclosure is 100 feet wide, 428 feet long and 20 feet high. The air-supported structure can cover an area as big as one acre.

DETECTING CABLE BREAKS has been made much safer and easier because of an ultrasonic detecting device (below) developed at Bell Telephone Labs, Murray Hill, N.J. Broken telephone lines give off an almost inaudible "hiss" containing energy in ultrasonic frequencies, as from a leak in a bicycle tire. Reflectors on the device direct the energy of the hiss into the microphone of the detector, eliminating coming in contact with a hot wire.

MINI SUBMARINE (above) is called "Guppy" by its developer, the Sun Shipbuilding Co., Chester, Pa., because of its resemblance to its namesake. Guppy is very lightweight compared to other submersibles; it weighs only 5,000 pounds, which is lighter than the batteries alone on some submersibles. It operates under water while tethered by an electric cable to a support ship or platform. Guppy comes with many equipment options.

The American Museum of Natural History . . .



by Barbara Ford

YOU CAN HARDLY climb aboard a bus or subway in New York City these days without seeing a dinosaur. Not a real one, of course, but a poster that shows the smiling reptile wearing a birthday cake as a hat. The occasion? The American Museum of Natural History, which has, among other things, an unparalleled collection of dinosaur bones, is having its 100th birthday this year. To celebrate, it's opening a battery of new halls guaranteed to give sore feet to even the strongest visitor.

To visit the centenarian, you can catch a bus or subway up to Central Park West and 77th Street in Manhattan, the museum's home for most of its long career. In the ground floor foyer is a whale-shaped arrow pointing to the biggest and most popular new hall, Ocean Life. As you approach the hall, the head of a 94-foot model of a blue whale looms up in the entrance. The huge creature is suspended from the 50-foot-high ceiling by an invisible iron bar (see "New whale for an old fish hall," *Science Digest*, March 1969). Most visitors coming in the hall stop to stare at the whale for a good half minute before they read about it.

"They were going to have a contest to give it a name," says Dr. Richard Van Gelder, chairman of the museum's department of mam-

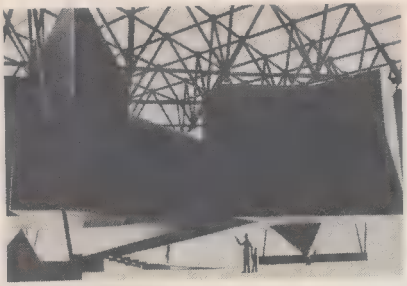
100 years later

malogy and the man responsible for the scientific accuracy of the mammals in the hall. He said, "Why not call it Jesus? That's what everyone says when they first see it. But I guess it really doesn't need a name—it's just The Whale." The contest idea, he notes, was shelved.

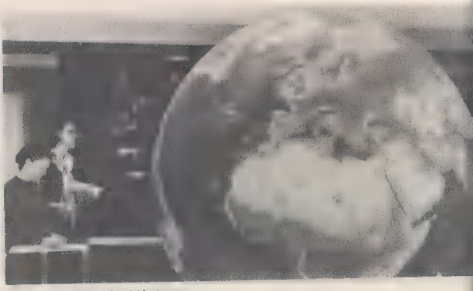
The Whale weighs 10½ tons, is made of Fiberglass and Polyurethane over a steel frame, and took two years to construct. Too big to go through the doors, it was put together on the floor of the hall and raised to the ceiling by a hoist. The model is based on a real blue whale, a female captured off South Georgia Island in 1925. "It's built as accurately as any whale model can be built," says Dr. Van Gelder. "Very few people have ever seen a real blue whale. The main stands of them are almost extinct. But I called in a Canadian expert who *thinks* he's seen a blue whale to check on our whale."

There's much more to the huge Hall of Ocean Life—160 feet long and 120 feet wide—than the blue whale. Smaller whales and other aquatic mammals occupy the lower part of the hall and a balcony is devoted to the biology of fishes. The aquatic mammals are in what the museum calls "habitat groups"—animals in a lifelike position in surroundings simulating those of the natural habitat. In one display case is a polar bear, its fur very yellow

Four new halls that



Can Man Survive



Hall of Earth History

Hall of Ocean Life

against the ice floe background.

"Some people are surprised to see a polar bear in an ocean life display," says Dr. Van Gelder. "But a polar bear probably never sets foot on land in its whole life; it's always on an ice floe in the Arctic Ocean."

For all its new exhibits, the Hall of Ocean Life is really an old-style hall, typical of the kind which have made the museum world-famous. It offers habitat groups with a minimum of easily-digested information. The other new halls are different.

The Lindsley Hall of Earth History on the fourth floor (the museum has five floors, the top one occupied by labs and offices) starts off with a color movie that shows how the earth began. It has plenty of action —eruptions, floods, sandstorms, etc. —and the kids watching it seem enthralled. "We were surprised that children who tend to be in a holiday mood when they come into the hall watch the movie in a serious mood," remarks Dr. Norman Newell, chairman of the department of fossil in-

celebrate the 100 years

All Photos The American Museum of Natural History

Hall of Man in Africa (above) joins the museum's other three new halls for the centennial celebration as a very attractive, educational presentation of African ethnology. While the Hall of Ocean Life, which houses The Whale, is basically in the traditional museum style, the other three new halls are quite unusual. Can Man Survive is probably the most controversial of the three, giving man a look and feel of what he's doing to his environment and asking if he can survive progress. The Hall of Earth History is more of a teaching hall than any of the others.

vertebrates and the scientist in charge of the hall. Basically, he points out, the hall is a teaching hall designed to convey some basic concepts of earth history. You can't walk quickly through it and get much out of it; it requires study.

On a recent afternoon, a sprinkling of intent adults and older children were examining the displays. "Hey, I feel like Zeus," one pre-teen black youngster told his friend as they hovered over a floor display of the Bahamas Islands. Two Columbia students searched, notebooks in hand, for trilobites, an extinct invertebrate, among the habitat groups showing how the earth looked in various geological periods. "I've found them," one student announced. "Ordovician and Devonian." A middle-aged man and his wife stood for a long time in front of a case of cephalopods, the class of mollusks to which the squid and octopus belong. "But how do you know when you see a cephalopod that it isn't a snail?", the man asked his companion plaintively as they moved on. "I still don't understand that."

The concepts in the hall are illustrated as attractively as possible, Dr. Newell points out, in line with the theory that the nicer a display of cephalopods looks, the more people will take the trouble to examine it. "And if they can't understand it, they can at least enjoy it," he adds.

Selectivity is the key word in the third major hall opened recently, the Hall of Man in Africa. The museum has a huge collection of fine African pieces, some old, many new, but relatively few of them appear in the new second floor hall. "This hall was not designed from the collection, it was designed theoretically," emphasizes Dr. Colin Turnbull, an anthropologist and curator of African ethnology at the museum. "I gave Henry Gardiner, our chief designer, a reading list on Africa and he attended a lecture course. We spent a year just talking about the hall. From a purely theoretical background, Henry drew up a floor plan. Then we went to the collections and pulled out pieces to illustrate our ideas."

The collaboration has resulted in one of the most attractive halls at the museum and one that encourages in-

tensive study by a large percentage of visitors. It's divided into the four physical environments of Africa: desert, forest, grassland and river valley. Within each section, individual cases treat various aspects of African life: "The Spirit World," "Science and Faith," "Women," "Water and Politics" and so on. Three big habitat cases and some of the other cases are round with conical roofs like African huts. Soft grass-green carpeting c u s h i o n s footsteps and African chants play in the background.

In front of an exhibit on slavery and the Afro-American tradition, a pretty young black teacher talks with her small black pupils. "What did they do with those slaves?" she asks, pointing to the case. "They sold them," pipes a voice. "Why?" "To make money," offers a child. "That's right," says the teacher. "The more slaves they sold, the more money they had. See that man up there on the platform? He's selling t h o s e Negroes. That's a slave auction."

The Hall of Man in Africa, like most museum halls, is concerned mainly with the past, an emphasis that makes it virtually timeless, although Dr. Turnbull hopes to make frequent minor changes. "Can Man Survive?," the museum's special centennial exhibit that deals with man's exploitation of his environment, will bow out of the Roosevelt Memorial rotunda in just two years. Essentially, it's a series of interconnected tunnels that hang from a device called the Takanaka truss. You enter an air-conditioned tunnel that broadens out into a room in which a split-screen movie about jungle life is showing. Then you plunge into another tunnel and enter an area that looks like a factory—pipes overhead and machinery on the floor. A projector throws images of technological phenomena on a screen while a tape recorder accompanies it with bleeps, whines and whistles. In the next and last section, technology has gone sour. Realistic slime oozes out here and there and photographs of tired-looking city dwellers peer down from the walls. On one surface is a slogan: "We have met the enemy and they are us—Pogo." Two movie screens are going like mad, while voices in a variety of American accents boom out things like, "You can't let a little smoke stand in the way of progress."

The museum has never had anything quite like "Can Man Survive?" and not everyone likes it, including s o m e museum personnel. But a quick survey outside the display indicates that some people *do* like it. A retired employe of the Missouri State Highway Department says, "It costs us $3 million a year to pick up the litter on highways in Missouri and this brings it to light." One of a pair of mini-skirted teen-agers says, "We went through it twice. I think it really gets across the message that it's up to us to stop all this pollution." Her friend nods. But a 14-year-old boy in a pink shirt disagrees. "I thought it was ridiculous—a bunch of cameras flashing and everything." He stalks off into the famous Hall of African Mammals which was opened in 1936 and hasn't changed a tooth or claw since then.

The American Museum of Natural History, fortunately, is big enough for everyone—especially this year. ■

For further reading

BANKERS, BONES AND BEETLES. *Geoffrey Hellman. Natural History Press. 1968.*

Drawing courtesy of Science © 1969 American Assoc. for Advancement of Science

Man, orangutan, capuchin—comparison of their vocal tracts (dark areas) by V. E. Negus, shows that nonhuman primates lack the physical make-up necessary to talk. Pharyngeal region like man's, where root of the tongue forms movable anterior wall, is missing.

You can't teach a monkey how to talk

EVEN THE SMARTEST MONKEY or ape can't learn to talk, research at the *University of Connecticut* indicates.

Dr. Philip H. Lieberman, a linguistics expert and electrical engineer, claims that the formation of an ape's or a monkey's vocal tract prevents it from imitating human speech. Basically, the non-human primates lack a pharyngeal region like that of man. The pharynx, which changes continually during human speech to produce a wide range of vowel sounds, is the part of the throat above the larynx or voice box.

Other factors that make speech impossible for monkeys are that their vocal cords produce irregular and uncontrolled vibrations and that their tongue doesn't move. Man moves his tongue almost constantly when he's talking.

Dr. Lieberman used records of primate sounds, an anesthesized rhesus monkey, a plaster cast of the oral cavity of a rhesus monkey and a computer to reach his conclusions. He fed measurements from the casting and the anesthesized primate's vocal tract into the computer, which was programmed to explore the full range of sounds the monkey could produce if it used all its resources.

In nature, Dr. Lieberman's monkey and ape recordings show, the animals do not use even this limited vocal equipment to make sounds. They usually produce only one vowel, a "schwa." (The first vowel sound

in the word "about" is a schwa.) The only exception found was a cry that chimpanzees make with rounded lips.

Early man had a similar physical inability to talk, Dr. Lieberman points out. Skeletal remains of the earliest fossil ancestors of man indicate that they had sound-making equipment very similar to that of present day monkeys and apes. The series of changes in the primate vocal tract that occurred in evolution may have been necessary for speech.

In his most recent study, which involved X ray movies of newborn infants, the linguistics professor found that the vocal tracts of babies look much like those of monkeys. The newborn human's larynx is placed high in the neck, limiting the pharyngeal area. Apparently the infants produce their cries without moving their tongues, too. By their sixth week of life, however, the newborn babies begin to make sounds beyond the abilities of apes and monkeys.

"Just as the ability to use tools depends in part on our having an opposable thumb and an upright posture, our ability to talk depends on our having a mouth, tongue, larynx and pharynx that are adapted towards speech production," Dr. Lieberman sums it up.

Gravedigging a ghost town

Surprisingly little is known about the anatomy of Americans of just 100 years ago, an information gap *Florida State University* anthropologists are trying to close. They are digging up skeletons in a long-abandoned graveyard in the ghost town of St. Joseph on Florida's Gulf Coast. St. Joseph was a boomtown that arose quickly and died just as quickly after a yellow fever epidemic raged in 1841. Now only the well-filled graveyard remains. The Florida State team expects to unearth up to 200 skeletons from the unmarked, overgrown graves that will reveal data about diseases, stature, age, sex.

Cats confound sleep study

Cats kept awake in a laboratory experiment at the *University of Southern California* for as long as two weeks at a stretch showed no ill effects and seldom even appeared sleepy. The research is calling in question some widely-held theories about sleep.

Dr. John E. Holmes, a professor of physiology and neurology at USC, kept the cats awake by applying a mild, steady electric current to an area of their brain known to control wakefulness. The current was turned off only when the animals were being tested and weighed. Lab personnel watched the cats' food intake and pulse closely and monitored their brain waves.

The cats appeared sleepy only after they were returned to their cages after being tested, Dr. Holmes reports. A slightly stronger current applied for a short time alleviated the drowsiness. When the current was finally discontinued, the animals stayed awake for about half an hour and then slept. The one cat kept awake two weeks slept eight hours.

Humans kept awake for prolonged periods with different methods have become groggy, irritable and inefficient. Some had hallucinations. ■

Pelicans: those high-diving fishermen

IT TAKES A LOT of fish to satisfy a pelican, one of the top, if not *the* champion, eaters of the animal world. Always on the lookout for dinner, one or two of these hungry birds will follow a school of fish for several miles, gliding gracefully over the ocean at from 10 to 50 feet above the surface. Suddenly, the pelican sights a fish, climbs higher and then shoots down into the water for its prey, bill pointed at the target like a spear. It grabs the fish in its enormous bill, the bottom part of which distends into a pouch of skin to hold the prey.

This sequence of photographs was shot at Silver Springs, Fla., by means of a glass-bottom boat. The pelican shown is a brown pelican, a species that usually frequents the ocean, but this specimen and several others were captured, clipped and transported inland for picture-taking. Released from the glass-bottom boat, the birds adjusted to their new surroundings in a few hours. Then, in the clear waters of the springs, they demonstrated just how they manage to fill their hungry bellies with food every day. The dive shown is a successful one, like most of those recorded, but the photographer saw the pelicans miss a fish or two.

About 10 species of pelicans are

Beginning its dive, a brown pelican points its long bill at the fish below like a sword.

Into the water goes the pelican (above), bill extended to grab the unlucky fish (below). It plops the fish into the bottom part of its bill, which distends enormously to accommodate the prey (center). After swallowing the fish, the pelican, bill shrunken to normal size, emerges from the water (right), ready for more flying and fishing. Pictures were snapped by means of a glass-bottom boat in the clear fresh waters of Silver Springs, Fla., with the brown pelican, which normally is an ocean-living bird.

known, three of them from the U.S. The brown pelican lives in the southeastern U.S. and tropical America; a very similar bird inhabits the Pacific Coast. The larger white pelican—it reaches a length of five feet, with a wingspan of up to ten feet—lives in the western U.S. Unlike the brown pelican, the white doesn't dive for fish. It swims along, catching the fish as it proceeds through the water. Sometimes groups of white pelicans drive fish into the shallows, where they can catch them at leisure. The white pelican lives on both fresh and ocean water, but the brown is strictly an ocean bird. ■

Photos Kurt Severin

The 15 most important drugs

by Arthur J. Snider

A CONSENSUS of medical authorities has selected the 15 most important drug advances in the last 10 years. Vaccines for measles, mumps and polio head the list. Other agents are:

Ampicillin (trade names Penbritin and Omnipen)—a semi-synthetic penicillin effective in treatment of many types of meningitis and severe intestinal and respiratory diseases.

Methicillin (Staphcillin)—the first penicillin effective against staphylococcus infections resistant to ordinary penicillin.

Oral contraceptives—combinations of hormones to inhibit conception.

Chlorothiazide (Diuril)—the first of the oral diuretics, used widely to treat high blood pressure.

Clofibrate (Atromid-S)—a drug capable of reducing elevated cholesterol and triglyceride (another fat-like substance) in the blood.

Actinomycin D (Cosmegen) and vinblastine (Velban)—drugs effective in inducing temporary improvement in certain types of cancer.

Imipramine (Tofranil)—first of a group of stimulants effective in many patients with severe depression.

Propanolol (Inderal)—a drug for disorders of heart rhythm.

Clomiphene citrate (Clomid)—a drug which improves fertility, sometimes causing multiple births.

Griseofulvin (Fulvicin, Gufulvin, Grisactin)—the only drug taken orally which is effective against many fungus infections of the skin and fingernails.

Allopurinol (Zyloprim)—an effective anti-gout drug.

The selections were made by the consultants to *The Medical Letter*, a non-profit, independent publication which publishes evaluations of prescription drugs for physicians.

Among other agents singled out in the survey were a specific treatment (carbamazepine) for tic douloureaux, a painful nerve disorder; guanethidine, an agent for severe cases of high blood pressure; four anti-bacterial agents (oxacillin, cephalothin, gentamicin and ethambutol) and four anti-cancer drugs (melphalan, cyclophosphamide, flouro-uracil and vinicristine).

The cardiac pacemaker to help normalize the beating of the heart, the electric shock defibrilator to restore the heart to normal rhythm when abnormal rhythm occurs and radioactive isotopes to scan organs for diagnosing organic disorders were cited as significant treatment and diagnostic devices.

Turning off to smoking

Some people would rather be switched than smoke. They are willing to undergo unusual punishment in an effort to give up the habit. They swallow pills certain to nauseate them as they inhale or that taste like an unpleasant mixture of spices. They undergo regular schedules of shocks as they smoke in the labora-

tory. Or they may carry small electric shock instruments in their pockets.

At the University of Notre Dame, half a dozen persons sit in a small study room and blow cigarette smoke at each other in a furious fashion until their eyes water and they feel like vomiting.

All of the punishing techniques are a form of what is called "aversive conditioning." Many anti-smoking clinics are experimenting with it.

"Among the reasons people smoke," says Prof. Thomas L. Whitman of Notre Dame University, "is that they find pleasure in it. We try to disassociate pleasure from smoking. Instead we try to associate it with pain or discomfort, using foul-tasting pills or shock."

Nuclear-powered pacemaker

A light, compact nuclear-powered pacemaker, about two-thirds the size of a package of cigarettes and weighing only three ounces, has been implanted in a dog at the National Institutes of Health as a replacement for the conventional battery.

Developed by the Atomic Energy Commission, the energy source is plutonium-238. It is capable of powering the pacemaker for 10 years.

Pacemakers are inserted in chests of patients with abnormal heart rhythm. They are designed to maintain the rhythm at a pace that will sustain normal activity. One of their drawbacks is the need to reopen the chest periodically to replace the pacemaker's run-down battery. While the mercury batteries that power most pacemakers are designed to last five years, most surgeons elect to replace them in 24 to 36 months to provide a margin of safety. In some instances, the batteries have run down in a few months.

If studies on dogs during the next year prove that a nuclear-powered pacemaker is successful, the device will be inserted in patients at Beth Israel Hospital, Newark, N.J., by Dr. Victor Parsonnet.

Plutonium-238 was selected as the energy source because its rays have

low penetrating power. They can be stopped by a thin piece of paper. Thus the need for special radiation shielding material is eliminated. Stray radiation is no greater than that from the radium dial of a wrist watch.

Fertility sound blast

Infertile women are being stimulated to ovulate by sound therapy. They are placed in a small, soundproof room at Abraham Jacobi Hospital in the Bronx, N. Y., to hear piercing blasts of pure sound for one minute out of every ten.

The theory behind the treatment

is that auditory stimuli can trigger the release of hormones needed for ovulation. It has been demonstrated in experimental animals that pure sound has this capability, although the reason is not understood.

Dr. Claude J. Meyer of Albert Einstein College of Medicine told the American Fertility Society meeting that ovulation has been induced

in seven women. One achieved pregnancy.

He believes that the technique has an advantage over the drug Pergonal, a powerful inducer of ovulation which must be given at a precise time in the woman's cycle.

Dr. Meyer is now developing a do-it-yourself method in which cassettes are played at home on an ordinary tape recorder.

Washington not a father

George Washington may have been sterile, in the belief of a Richmond, Va., urologist. The father of our country could have been afflicted with a type of Klinefelter's Syndrome whose symptoms include sterility.

"One of Washington's biggest disappointments in life was that he never fathered any children," says Dr. Smith. "His wife Martha was married and widowed before she and Washington met. She had four children by the previous marriage, two of whom lived, so her fertility was unquestionable."

Many portraits of Washington are completely inaccurate and "stylized aggrandizement of the hero," adds Dr. Smith, a professor at Medical College of Virginia. The hero was probably broad-hipped and big-breasted, also symptoms of Klinefelter's Syndrome.

Spotting finger-biters

A disease that leads children to bite away portions of their lips or actually bite off the ends of their fingers if given an opportunity can now be detected before birth, according to Dr. J. Edwin Seegmiller of the National Institutes of Health.

The condition, called the Lesch-Nyhan syndrome, is usually seen in children who are cerebral palsied and have mental retardation. The tendency to bite themselves is termed a compulsive aggressiveness over which they have no control. They have full sensation of pain and they're quite aware of what they are doing. Often they seek the help of those around them in restraining their arms and hands so that they cannot get them into their mouths.

Dr. Seegmiller, chief of the section on human biochemical genetics, says Lesch-Nyhan syndrome fortunately is a rare disease. But what makes it important is that it has become a model of how to study diseases produced by genetically inher-

ited mistakes in body chemistry.

In the Lesch-Nyhan syndrome, the most obvious chemical sign of the disease is a surplus of uric acid, the same chemical that is blamed for gout. There is now a drug that can prevent formation of uric acid by the body, Dr. Seegmiller told the American Chemical Society. Known as allopurinol, the drug also helps prevent the kidney damage that the children would otherwise get from the large amount of uric acid they produce.

It is not yet known whether the uric acid also is the cause of the compulsive biting. But Dr. Seegmiller and his colleagues have devised a screening test to catch victims of the syndrome at an early age so that treatment can be started in time to protect them. Dr. Seegmiller has proposed that pregnant women known by family history to be carriers of the disorder be screened for the possibility of bearing a potential Lesch-Nyhan victim.

Inoculations for travelers

It's important to take advantage of all the protection afforded by immunization before embarking on the vacation trip abroad, but it is foolish and occasionally dangerous to subject one's self to a rigid, complete series of inoculations, cautions Dr. Kevin M. Cahill, director of the Tropical Disease Center, St. Clare's Hospital, New York City.

For example, plague is endemic today only in Vietnam, Laos and Cambodia. Typhus inoculation is necessary only for those visiting the highlands of Ethiopia, Ecuador, Peru, Bolivia, Colombia and Mexico.

"Even for visitors to these countries, it is worth considering whether there will be real exposure before receiving typhus," Dr. Cahill advises.

Smallpox vaccination is required for reentry into the United States from every nation except Canada and Mexico. A validated vaccination certificate is required every three years for travelers. If one is going to a zone where smallpox has been prevalent, it is wise to have a fresh vaccination.

Typhoid vaccination is advised by Dr. Cahill for visitors to a tropical area. For those who have had a typhoid series in the last 10 years, a single booster is sufficient.

Some people have adverse reactions to typhoid shots, but these can be minimized by taking aspirin or applying an ice pack.

Tropical visitors must keep their

tetanus immunity up. Dr. Cahill usually gives adults tetanus and diphtheria shots combined and few reactions are noted.

Polio vaccination also is strongly recommended for tropical visitors since there are many areas where polio is still prevalent.

Yellow fever immunization is necessary for travelers to any countries in the middle third of Africa and the northern third of South America and throughout Central America and parts of Mexico. This cannot be obtained in a doctor's office. It is administered at a federal or local health office because it must be used soon after being prepared.

Cholera inoculations are required by visitors to or from all countries east of Suez and west of Hawaii. Anyone who has received a series of cholera inoculations need not undergo the multiple injections again. Only a booster dose is required.

"One of the most important inoculations one should get before traveling to the tropics is gamma globulin," says Dr. Cahill. "It appears to provide a 70 to 80 percent protection against hepatitis for about five months."

Although great progress has been made in certain parts of the world in the eradication of malaria, all of Africa and much of Central America, South America and the Near and Far East remain heavily afflicted. The most important tablets a traveler can take are chloroquine diphosphate, marketed in this country as Aralen. After leaving a malarious area it is important that chloroquine be continued three weeks, Dr. Cahill says.

Electric prostate 'knife'

A six minute "dry" operation using an electrical cutting current has been developed by urologists and used with good results on 35 of 50 men with enlarged prostatic glands.

Dr. Irving M. Bush, chairman of the urology department, Cook County Hospital, Chicago, says the transurethral dessicator (TUD) cuts away obstructing tissue when applied for 15 to 45 seconds at a time in 3 to 12 applications.

Enlargement of the prostate gland is a common condition in men past 50. Dr. Bush estimates 10 to 30 percent of all males eventually will need a prostatic operation.

Knife surgery, however, requires prolonged convalescence after about a two-week period of hospitalization. The electrical surgery procedure averages six minutes and brings little or no blood loss. A minimum of anesthetic is required.

Gallstones: persistent nuisance

Gallstones can remain as dormant as Rip Van Winkle, then suddenly flare up. Gallstone disease ranks fifth among causes for hospitalization. For years patients were hesitant about an operation because of rumors that removal of the gallbladder would not necessarily free them from symptoms. Now it is the third most common operation.

High stomach distress is usually the first and at times the only type of pain resulting from a stone distending the gallbladder or bile duct, says Dr. Robert M. Zollinger, chairman of the department of surgery, Ohio State University. Shortness of breath may accompany this pain and in middle-aged patients may be misinterpreted as a heart attack.

Positive demonstration of stones is the finding surgeons seek before operation. When X rays show stones, they are recovered in about 99 percent of cases. In about one out of every five patients with gallstones, a rupture of the diaphragm has been found, Dr. Zollinger says. ■

BIPS Photos

Like a space age mushroom, the unique Foster house slowly revolves in Wilton, Connecticut.

Life in a revolving house

"LET'S GO for a spin in the country" is a phrase the architect Richard T. Foster can use a lot these days. He has just moved his family into a house that revolves like a space age merry-go-round.

Located in the countryside of Wilton, Conn., a suburban community near New York City, the Foster house looks like a cross between an avant-garde mushroom with a stubby stem and some sort of perched flying saucer.

Foster tore up four different house designs before he hit upon the idea of a revolving house. "You see, the problem with the building site was that it was too beautiful," recalls Foster. "I just couldn't make up my mind which direction the house should face."

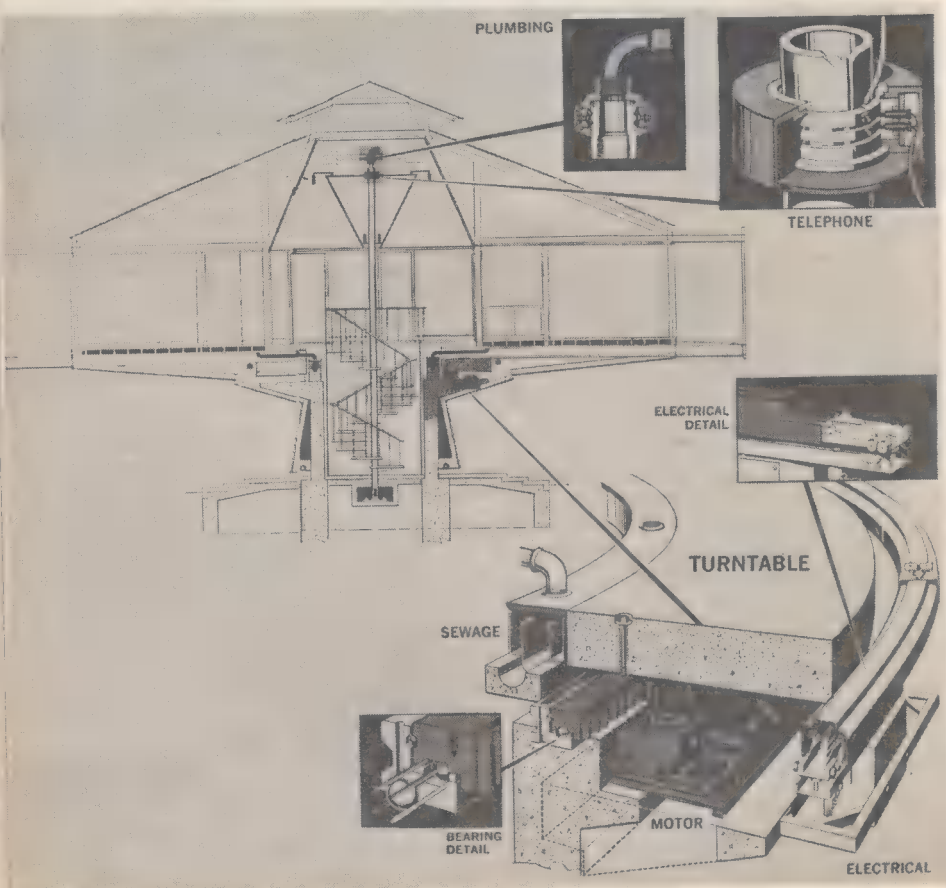
The idea of making the house spin solved that dilemma nicely. But what's it like to live in a carousel house? The living room may face the pond in the morning, the pine woods in the afternoon and the rolling hills in the evening. As one room moves so do the others.

When the house is going at top speed, it can make a full turn in 48 minutes, but even then there's no sensation of movement. It's only when you glance out of the window

after a couple of minutes and find the scenery changed that you realize that you're moving at all.

Foster won't say, but expert estimates of the cost of the house are around $250,000. He will admit, however, that it was an engineering nightmare to build. Ordinary utility connections like plumbing, gas and electricity would twist themselves into a tangled mess in no time. The drawing below shows how he solved the problems. ■

Engineering nightmare was overcome by borrowing techniques from industry. House rests on a series of huge ball bearings like the kind used in gun turrets, radar antennae and heavy earth-moving shovels. A 1½-hp electric motor makes the turntable revolve and costs no more to run than a refrigerator does. Plumbing was solved by using a water valve which rotates 360°—an idea borrowed from the oil industry. Power supply is mounted on a trolly especially shaped for the round house. Tanks for the oil furnace are under the roof. Radar commutators were used for telephone connections. Visitors enter through a door in the supporting stem at ground level and climb a spiral staircase to the living area.



View of rolling hills (above) changes to a Connecticut pine woods (below) after just 48 minutes.

ISAAC ASIMOV EXPLAINS

Each month Dr. Isaac Asimov chooses one of the questions you send in to answer. He does not make the job easy on himself, for in past months he has written about such things as relativity, parity and the basic nature of light. Following Dr. Asimov's answer are the answers to some of your other questions written by regular members of the *Science Digest* staff.

Do antiparticles produce antienergy?

Do antiparticles produce antienergy?

At the beginning of the 20th century, physicists began to understand that all matter consisted of certain different kinds of particles. In 1930, an English physicist, Paul Dirac, working on the mathematical theory of those particles, decided that each type of particle ought to have its opposite.

For instance, the electron has a negative electric charge and the proton has a positive electric charge of exactly the same size, but the two particles are not opposites. The proton, it seems, is much more massive than the electron.

There ought to be, according to Dirac, a particle with the same mass as the electron but with a positive electric charge; and one with the same mass as the proton, but with a negative electric charge. These were indeed detected eventually, so that we now know of an "antielectron" (or "positron") and an "antiproton."

The neutron has no electric charge at all, but it has a magnetic field pointed in a certain direction. There is an "antineutron" which also has no electric charge but which has a magnetic field pointed in the opposite direction.

It seems to be a law of nature that one particle can be turned into another particle, but that whenever a particle is formed without the previous existence of a particle, an antiparticle must be formed with it.

Here is an example. A neutron will turn into a proton and that in itself seems to be okay since one particle has turned into another. In the conversion, though, an electron is also formed. This means one particle has turned into two particles. To balance that second particle, a tiny antiparticle called an "antineutrino" is also formed.

A particle (the neutron) has turned into another particle (the proton) plus a particle/antiparticle pair (the electron and antineutrino).

Particle/antiparticle pairs can be formed out of energy, and particle/antiparticle pairs can be turned back into energy in any numbers. You can't form just a particle out of energy; or just an antiparticle—but you can form the pair.

Energy itself is made up of "photons" and a question arises as to whether a photon is a particle or an antiparticle. There seems no way of turning a photon into an electron, for instance, so it can't be a particle. There's no way of turning it into an antielectron, either, so it can't be an antiparticle.

However, a sufficiently energetic gamma-ray photon can be turned into an electron/antielectron pair. It would seem then that the photon is itself neither a particle nor an antiparticle but a particle/antiparticle pair all by itself.

Every photon is an antiphoton as well. To put it another way, a photon is its own opposite.

You could look at it this way. Suppose you folded a sheet of paper down the middle, dividing it in two and put the names of all the particles on one side and the names of all the antiparticles on the other side. Where would you put the photon? Right on the crease!

For that reason the energy produced by a world of particles consists of photons and the energy produced by a world of antiparticles consists also of photons, with no difference between the two. The energy is the same either way and there is no such thing (as far as we know at present) as antienergy.

—Isaac A. Asimov

What is detergent as opposed to soap?

Though often thought of synonymously, detergents are synthetic cleansers made from chemicals usually obtained from coal or oil, and soaps are made by the action of alkali on fat or fat acids, consisting mainly of sodium or potassium salts of fat acids.

There are definite advantages to detergents. They are more efficient than soap in hard water because they don't form a hard scum with the minerals in the water and therefore none of the detergent is wasted.

The great disadvantage to detergents is the long-term effect they have on the water and the additional pollution problem that is a result of the tremendous popularity of these cleansers. Because they contain substances which are difficult to get rid of, the chemicals in the detergents build up in the water, causing its deterioration. This water pollutant must be taken into consideration in complicated physical and chemical water separation processes.

There is also evidence that these chemicals are harmful to fish and other aquatic life. Unfortunately, it is not too uncommon to see masses of detergent foam floating in rivers and streams today. It appears that a closer look at the pros and cons of detergents might be called for.

Please address all questions to Isaac Asimov Explains, Science Digest Magazine, 575 Lexington Avenue, New York, N. Y. 10022

Advertisement

Do you ever talk to yourself the way I do?

"One evening I felt a sudden urge to have a little talk with myself about my own life . . . what I wanted *from* it, and what I intended to do *with* it.

"The idea struck me so suddenly that I turned off the TV right in the middle of my favorite program, and began this conversation that turned out to be about the most important I've *ever* had.

"The big Me, the Real Me, talked facts to the little me...and point by point, this is what I told myself.

"1. What I want and need is *something I can really believe in* to the very core of my soul, something that makes sense spiritually and philosophically...and at the same time has its practical meaning for the material world in which I have to live day by day. But —

"2. Conventional religious teachings and philosophy usually leave me a little disappointed. They don't seem to get to the *heart* of life, its meaning and its real values. So —

"3. There *must* be something else, some vital viewpoint which the Creator of all life really intended, something that I've been missing. Perhaps —

"4. The more mystical approach to life is what I'm really ready for, so —

"5. I'll send for Astara's book, *Finding Your Place in the Golden Age*. After all Astara has been teaching the mystical meaning of all religions and philosophies to students around the world for many years — they must have some pretty right answers.

"I sent for it that very night. It gave me new insight and understanding — and most of all, something I could really believe in.

"If *you* seek these things, why not send for *Finding Your Place in the Golden Age*. and see if it will help you as much as it helped me. The coupon is handy, and there's no better time than right now."

ADV. 6A

Robert and Earlyne Chaney, Directors
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"AN ASTARIAN IN NEED NEVER WALKS ALONE"

Cloud antenna for world communication

AN IONIZED CLOUD, which has been compared to an artificial meteor trail, is the key to a proposed global communication system. The cloud, to be created high above the earth in the ionosphere, would serve as an antenna, relaying broadcasts from the earth around the world.

Under the proposal, which is the subject of Patent 3,445,844, recently issued to the Raytheon Company, the signals would be sent through a "whispering gallery" in the ionosphere. The wave-guide duct between layers of the ionosphere functions much like the dome or gallery walls of a cathedral which reflect even faint sounds so that they can be heard great distances.

In 1966 the Air Force avionics laboratory at Dayton, Ohio, verified the existence of whispering gallery propagation by flying two satellites that Raytheon had built.

The inventors of the projected communications system are Dr. Mario D. Grossi, consulting scientist in the company's equipment systems group at Sudbury, Mass., and Dr. Pietro P. Lombardini, another Raytheon consultant.

On a laboratory scale, a small cloud, cigar-shaped and luminous, has been created at Sudbury inside a plexiglass sphere three yards in diameter.

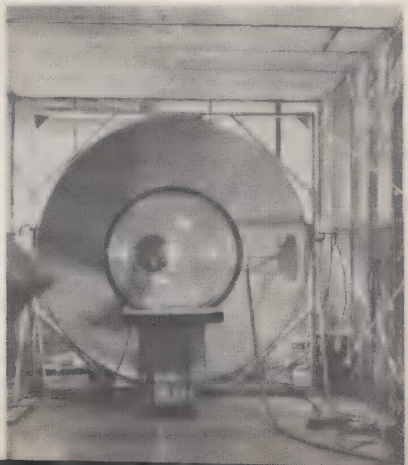
A real cloud would require government financing, as it might be 5 or 6 miles long and 50 miles above the earth. It would have to be generated by electric energy transmitted from a ground station.

Once the radio whispers are circulating in the ionosphere gallery, they will require another ionized cloud above each receiving station to get them out. Instead of a second cloud, an orbiting spacecraft could be used.

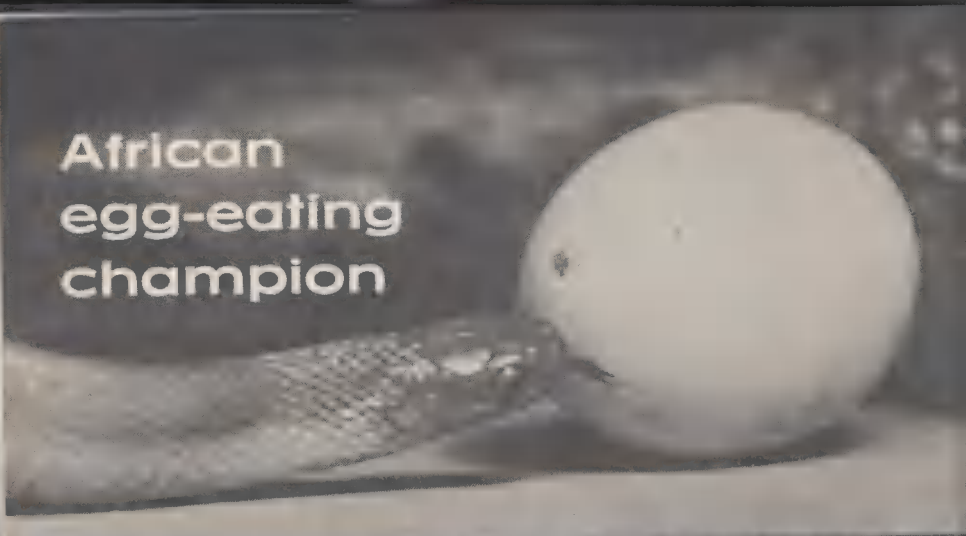
Although television images could be reflected off the meteor trail cloud, Dr. Grossi said recently that regular transmission through the whispering gallery would be confined to voice. —*Stacy V. Jones*

Plexiglass container three yards in diameter, with cigar-shaped ionized cloud at center.

Large mirror in background focuses S-band energy in center of plexiglass container (front).



African egg-eating champion



African Egg-Eater inspects egg several times diameter of its own body to see if it's edible (above). Deciding it would make a good meal, snake braces itself against a piece of wood and begins to swallow egg (below). Mouth, throat and gullet can be distended enormously (right) to accommodate eggs of varying sizes. If egg breaks now, the snake will spit it out.

SEEING an African Egg-Eating Snake (*Dasypeltis scabra*) down an egg several times the diameter of its own narrow body must rank as one of the wonders of the animal world. This three-foot-long, non-poisonous reptile will swallow a hen's egg stolen from a chicken coop in a village, or a wild bird's egg pilfered from a nest high in a tree. Then it expels the empty, crushed shell out through its mouth.

How does it do it? Its head, mouth, throat and gullet can be greatly dis-

Photos Kurt Severin

tended to accommodate eggs of varying sizes, its only food. In addition, it has a unique adaptation of vertebrae behind its gullet that enables it to crush the egg within its body, gnash the shell open and let the contents flow into its body and stomach.

The whole operation takes only 30 to 45 minutes. First the snake feels the egg with its tongue to find out if it's fresh and digestible. It will refuse eggs that are partly hatched, cooked or otherwise objectionable. If the egg passes inspection, the snake

begins the eating process. Pushing its body against a stable object for leverage, it distends its mouth, throat and gullet to accommodate the egg. The actual swallowing takes about five minutes. If the egg breaks at this point, the snake spits it out. Once swallowed, the egg is processed by the special vertebral "crusher" and expelled.

A hen's egg will last the small reptile about three weeks.

The African Egg-Eater is found all over Africa, but particularly on the savannahs. To satisfy its appetite for eggs, it has developed into an excellent tree climber and accomplished thief. ■

At this point, egg is entirely within mouth and gullet (left), but it's still intact. Within minutes, however, the crushing apparatus behind the gullet will smash egg. Convulsive movement of snake's body (above) compresses empty shell into tight bundle. Shell has been expelled from body, crushed and flattened (below). Whole operation takes between 30-45 minutes. An egg this size will last the slender three-foot reptile an average of three weeks.

QUIZ

How good are you as a chemist?

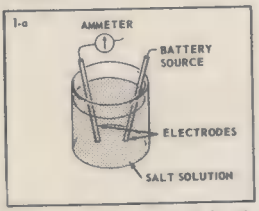
by John and Molly Daugherty

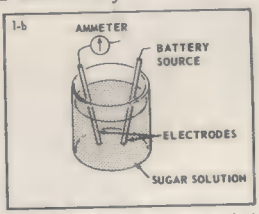
EARLY GREEK PHILOSOPHERS wondered about the nature of matter. Aristotle believed that matter was continuous and could be subdivided without limit. Leucippus and his pupil Democritus believed that matter was made of tiny indivisible particles called atoms. The word *atom* comes from a Greek word *atomos,* which stands for indivisible.

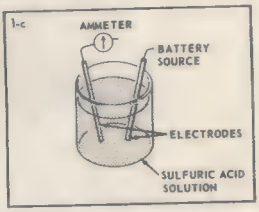
What do you know about the place of the atom in modern chemistry?

1. The chemical bonding of atoms in forming chemical compounds is of two kinds. One is electrovalent or ionic. The other is covalent or the sharing of electron pairs. If an ionic compound is dissolved in water, the ions dissociate to form an electrolyte, which conducts electricity. Covalent compounds do not.

Choose the picture in which electricity will *not* flow when the solution is connected to the source of electricity.

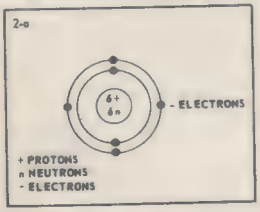


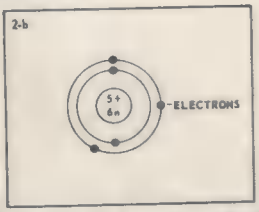


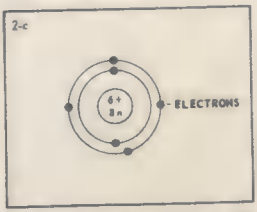


2. Atomic weight is the sum of the relative weights of the protons and neutrons in the nucleus of the atom. The relative weight of the electrons in the atom is negligible. Atoms of the *same* element may have different atomic weights. These are isotopes of that element and have the same or nearly the same chemical and physical properties. Lithium atoms have two isotopes. The most abundant one has an atomic weight of 7—3 protons and 4 neutrons. The other isotope has a weight of 6—3 protons and 3 neutrons. Atomic weight tables list the average as 6.94 for lithium.

Choose the picture which shows the radioactive isotope of carbon used in the carbon-dating process.



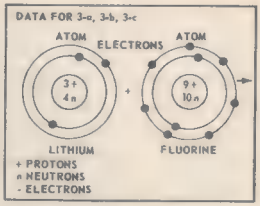


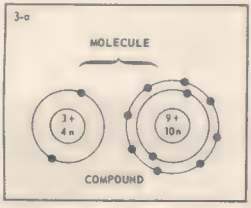


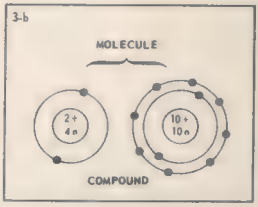
3. A chemical reaction takes place when the alkali metal lithium unites with the halogen fluorine to form the compound lithium fluoride. This chemical change is the electrovalent type (also called oxidation-reduction).

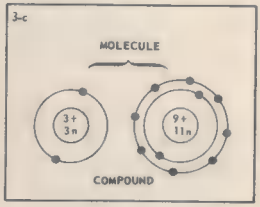
The *data* picture at right shows the electronic structure of the atoms of lithium and fluorine before they combine. *One* of the pictures *3 - a, 3 - b and 3 - c* shows the correct diagram of the molecule of lithium fluoride.

Choose the picture below showing the molecule of the lithium fluoride compound.

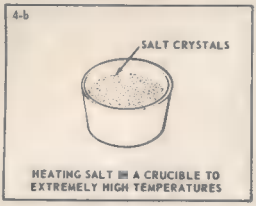


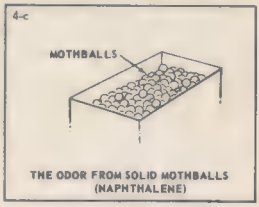






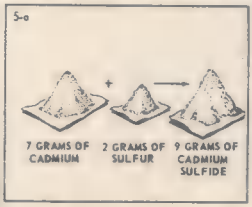
4. Under suitable conditions of temperature and pressure, most substances can exist in a state of solid, liquid and gas (vapor). A few substances skip the liquid stage—passing from solid to vapor directly. This is called sublimation. Choose the picture which does *not* illustrate sublimation.

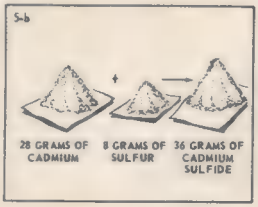


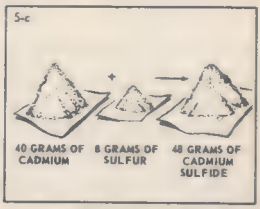


5. The Law of Definite Proportions was a fundamental step in the advancement of chemistry. This law states: If two pure substances combine to form a given compound, they do so in a definite proportion by weight. Question 5 gives an illustration of its application.

Choose the picture which is *incorrect* but can be corrected by changing the amount of the compound formed and by adding another quantity of matter to the right of the arrow.







Drawings by Sam Sims

Answers:

1-b Sugar solution. Sugar, $C_{12}H_{22}O_{11}$, is covalent and in solution does not form the positive and negative ions needed to conduct electricity.

In 1-a salt (Na^+C1^-) in solution dissociates into separate ions of Na^+ (sodium) and $C1^-$(chlorine). Charged particles conduct an electric current.

Because the salt molecule dissociates into two ion particles, it is doubly effective in melting the ice off your sidewalk in winter.

In 1-c sulfuric acid in solution dissociates into hydrogen ions and sulfate ions which makes the solution an electrolyte. The ionic formula for sulfuric acid is $H_2^{++}(SO_4)^{--}$.

2-c Radioactive carbon, often called Carbon 14 (C^{14}). This isotope of carbon has an atomic weight of 14—6 protons and 8 neutrons. The most abundant atom of carbon is shown in 2-a. This is Carbon 12 (C^{12}). Carbon 12 now is the standard of comparison for atomic weight tables (more accurately C = 12.0111). Formerly Oxygen 16 was the established standard. Oxygen now is listed as having an atomic weight of 15.999.

In 2-b the atom is *not* carbon since the atomic number is 5 (the number of protons) instead of 6. Atomic number 5 is boron.

3-a In this chemical change, the outermost electron of the lithium atom was transferred to the outer electron shell of the fluorine, where there was room for it to complete a stable octet of electrons. After this transfer, the lithium in the molecule of LiF becomes a positive ion with only 2 electrons left to balance the 3 protons in the nucleus. The atom of fluorine is now a negative ion with 10 electrons to balance 9 protons. Ions have different properties than neutral atoms.

In 3-b the electron configuration is correct, but the number of protons is incorrect. In chemical changes, the nucleus never changes.

In 3-c in the lithium ion, the number of neutrons cannot change.

4-b Salt. When salt is heated to extremely high temperatures, it becomes molten or liquified by heat. Salt (NaCl) has a melting point of 801°C. Its boiling point is 1413°C.

In 4-a wet clothes hung on a clothesline in winter under freezing temperatures will freeze, but after that they will dry because the ice evaporates.

In 4-c mothballs slowly evaporate, skipping the liquid stage.

Lead-colored iodine crystals sublime with gentle heating, too, and produce a beautiful violet vapor.

5-c Here the amount of cadmium sulfide formed is still 36 gm, but an excess of 12 gm of cadmium is left over. Thus, to the right of the arrow you would have: 36 gm of cadmium sulfide + 12 gm of cadmium.

In both 5-a and 5-b, the ratio of cadmium to sulfur is 7 to 2 since the ratio 28 to 8 reduces to 7 to 2. In all cases the total gm on the left of the arrow must equal the total gm weight on the right.

Score yourself:	**4-5 right**	You're a rare element!
	2-3 right	You've balanced your score, anyway!
	0-1 right	Your chemical reactions are slow!

Should man control his own destiny?

The Second Genesis: The Coming Control of Life. Albert Rosenfeld. Prentice Hall. ($6.95).

". . . I am the master of my fate;
I am the captain of my soul,"

wrote W. E. Henley in his famous poem *Invictus,* some years before he took his own life.

Actually, Henley's belief in his control over his own destiny was based not so much on factual control of the guidance and operational systems that steer us through this mortal coil; but to a pretty lusty ego and independent spirit.

Today, there is little question that mankind is on the threshold of a frightening ability to control his destiny—not just in his head, but in fact. According to Mr. Rosenfeld, science editor of *Life* magazine, the wonders that are about to reveal themselves could just as easily backfire and destroy us as did William Henley's presumptuous usurpation of what have been—up until now—Divine prerogatives.

We *will,* points out the author, soon be able to enlarge the capacity of human memory; to alter personality; to create human life without sex. Direct surgery on chromosomes will prevent congenital defects, will enable medical men to produce duplicate geniuses in all fields of endeavor. Genetic codes will be manipulated to design human beings to any specification desired—including creatures who never before existed—men (?) with special mutations enabling them to live in space, or under the sea (men with gills). Manipulation of body chemistry and neurophysiology will enable mortals to regenerate lost arms or legs; aging will be slowed, stopped and perhaps even reversed.

The fact is that man can, today, and will, in the future, be able to "tamper" with his body, his mind and his destiny. "Tampering" is the word Rosenfeld uses for what science is about to do with mankind. It may be pretty exciting, but it has some curiously frightening potentials, which the author points out vividly. How about the dictator, he asks, who c o m m a n d s the necessary electrochemical techniques to control mens' minds, as well as reproduction. He can raise ■ population to order artificially, plant electrodes in the brains. He can keep his people in a slave state—but stimulate the pleasure centers of their brains. No one would have a decent life; but all would be "happy." If everyone is h a p p y, would such ■ system be wrong?

"The answers (there are more than one)," points out the author, cannot be put off until the day such fantasies arrive. Some legal and moral enigmas already are with us. He cites cases: a divorced couple with a test tube child, for instance. The mother won custody; ex-husband was granted visiting privileges by one court; refused them by another because "he was not in any sense the child's real father."

If not, then who was, asks the author. Could the donator of the

semen demand custody? If so, should he be made legally responsible for the child, instead of the ex-husband? Could the ex-husband declare the child illegitimate?

There are a few of the nitty-gritty questions and dilemmas that arise with the kind of "tampering" that soon will deluge the human race, and will have to be dealt with *before* the fat is in the fire.

This is not the first book on the subject, nor is it likely to be the last. Gordon Rattray Taylor, British science writer, produced an equally thought-provoking book last year (reviewed in *Science Digest*, Oct., 1968). Mr. Rosenfeld's research is somewhat more up to date and his presentation is, perhaps, a little more sophisticated and astute. But the subject is a hot one; one that the public must become familiar with before all of us are caught up in an uncontrolled maelstrom of malevolence.—*RFD*

Other new books of interest

Come, Let Us Play God. Leroy Augenstein. Harper & Row. ($4.95). The ethical responsibilities involved in so many human decisions concerning science makes a fascinating topic for a book, and one that is likely to enthrall all readers. What advice should the doctor give a couple who fear the child they are expecting has a genetic defect? Who decides, or who has the right to decide which of two patients will get that artificial heart? There's much food for thought.

The Black Death. Philip Ziegler. The John Day Co. ($6.95). An often gruesome, but also gripping story of the horribly destructive plague that swept from Manchuria to the Black Sea to the Mediterranean and all across Europe in the mid-14th century chronicles the reign of terror that accompanied the plague.

Mysteries of Easter Island. Francis Maziere. W. W. Norton & Co. ($6.95). It seems the stories of Easter Island never grow old, probably because there are still so many mysteries concerning this old island with its hundreds of giant stone statues. This particular account is of a very small French expedition whose members lived with the native islanders for nine months. It is truly as much

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a story of Easter Island today as anything, and as such it gives great insight into the poverty, discrimination and ignorance that surrounds the life of the islanders, forbidden to leave by the Chilean government which rules the island. Assuredly, though, the importance of the great stone statues is not forgotten.

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Letters to the Editor

Illusions—black or white?

In your most interesting article on "Optical Illusions: Weird tricks your eyes play on you," there is one point I particularly find interesting. In talking about the experiment with black and white boxes in which black persons choose, or state rather, that both boxes are equal in size, you suggest that if this experiment were carried out today among black power advocates, the white box might seem smaller than the black box. The answer to this suggestion or hypothesis lies in the very same July issue of *Science Digest*. On page 28 is the article, "Black children choose white dolls." On the basis of this information, perhaps black persons still choose white boxes?

BERKLEY LAITE
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At the end of the "Black Children" piece, it's noted that two children from Black Muslim homes chose black puppets over white in comparison with the majority of black children in the study, who chose white dolls over the black.—Ed.

Optical illusion perception

In the article, "Optical Illusions: Weird tricks your eyes play on you," July 1969, I admire your success in integrating information from various laboratories — an accomplishment with which, I now see, we experimental psychologists offer too little help.

Your article remains my best chance to tell my family and friends what I do for a living—though I'll still have a hard time explaining why in the world Bell Telephone is willing to pay me to do it!

CHARLES S. HARRIS
Technical Staff Member
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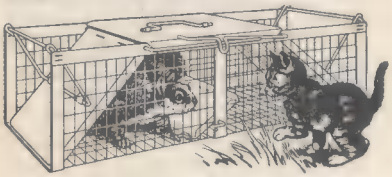

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view of the nighttime weather taken by HRIR sensor, Great Lakes are warmer than land and appear darker in color; clouds are colder than land or water and appear much lighter."

Is the reason for this because the picture was taken at night? I have been under the impression with normal black and white infrared film that heat given off by an object appears white indicating the heat and infrared radiation given off. A cool subject would appear dark. It is my understanding that with infrared color film, a cold object might appear blue and a warm object magenta. Do the sensors work differently than regular infrared film?

GENA ROMA
Philadelphia, Pa.

The usual arrangement of infrared photographs is that the warmest areas are the lightest, as you point out, but in processing the Nimbus infrared photographs, this arrangement is reversed, so that warm areas appear dark and cold areas light. Apparently the infrared photographs that are being produced by the new Nimbus IV are also reversed, according to our information.—Ed.

Fertile folk in South Dakota

In your March 1969 issue, an article, "The fertile folk," says that most of the Hutterites are in North Dakota, Montana and Canada. But under the heading of "Hutterian Brethren" in the Encyclopedia Americana, it is stated that "From Russia they came to the United States, settling in Bon Homme County, S. D., in 1874. The Bon Homme colony is still active and is regarded as the mother colony by the nine additional communes in

Advertisement

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A noted publisher in Chicago reports there is a simple technique for acquiring a powerful memory which can pay you real dividends in both business and social advancement and works like magic to give you added poise, necessary self-confidence and greater popularity.

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South Dakota, the eight in Montana and the nearly 30 in Canada in the provinces of Manitoba and Alberta." Not a word about North Dakota is mentioned. Would you please verify which is correct—North Dakota or South Dakota?

GHENG KAI-TUNG
Kowloon, Hong Kong

You are correct. In the United States, most Hutterites live in South Dakota and Montana, not in North Dakota, as we reported erroneously.—Ed.

'Fresh picked young potatoes'

In your Letters to the Editor of June 1969, one reader takes issue with processed potato food being advertised as made from "fresh picked, young potatoes," saying anyone familar with the harvesting of potatoes will realize how ridiculous that is.

Laying aside advertisements and processes of manufacturers, cooks, fadists, etc., and resorting to my own experience, graveling or picking fresh or new potatoes goes back 50 years. One simply removes some earth by hand or suitable tool in the potato hill, picks off a few that have developed and covers the exposed root so that others will develop. These are called new potatoes.

MAYNARD M. PIERCE
St. Louis, Mo.

Baby box—boon or bust?

If one is concerned about the process of dehumanization in society, let us not overlook innovations that have, by unguarded acceptance, degenerated into commonplaceness and abuse: the bottle replaced the breast and then the propping pillow replaced the cuddling mother at feeding time. After the promotional pitch has faded, will Skinner's baby box ("Suburban isolation controversy," June 1969) prove itself to be a boon or another Pandora's box?

VICTOR J. PATTERSON
Compton, Calif.

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Pictorial Parade

Tea is served

IT'S A LONG WAY from the rain forests of Africa to a tea party on the lawn at the London Zoo, but this young chimpanzee has adapted very well. Every day he has tea with a group of other chimps in the zoo—it's all a part of a stunt to amuse the visitors that gather to observe the primates. The normal chimp diet is fruits, leaves, roots and other vegetables—but what is London without 4 o'clock tea?

ADVENTURES IN

Science & Discovery

IN THIS ISSUE

A little girl with a very hairy face along with several members of her family, were born with long hair like that of an Angora cat covering their entire bodies. Their disease is called hypertrichosis. See page 14.

Are you polluting your own home? Most of us are, even though we don't realize it. Bug sprays, cleaning fluids, greases from the kitchen and radiation from appliances endanger us all every single day. Page 22.

High-diving birds Pelicans catch fish by diving into the sea from heights of 50 feet. See them fishing on page 67.